

BRITISH SURGICAL PRACTICE

SURGICAL PROGRESS

1956

Under the General Editorship of

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BUTTERWORTH & CO. (PUBLISHERS), LTD.
LONDON

AFRICA: BUTTERWORTH & CO. (AFRICA), LTD.
DURBAN: 33/35 BEACH GROVE

AUSTRALIA: BUTTERWORTH & CO. (AUSTRALIA), LTD.
SYDNEY: 8 O'CONNELL STREET
MELBOURNE: 430 BOURKE STREET
BRISBANE: 240 QUEEN STREET

CANADA: BUTTERWORTH & CO (CANADA), LTD.
TORONTO: 1367 DANFORTH AVENUE

NEW ZEALAND: BUTTERWORTH & CO. (AUSTRALIA), LTD
WELLINGTON: 49/51 BALLANCE STREET
AUCKLAND: 35 HIGH STREET

MADE AND PRINTED IN GREAT
AT THE CHAPEL RIVER PR
ANDOVER, HANTS

PUBLISHERS' ANNOUNCEMENT

THIS 1956 *Progress Volume* is the sixth of an annual series of supplements to *British Surgical Practice*. By this means the eight volumes of the main work are kept up to date in the ever-increasing field of surgical knowledge by original articles, critical surveys and abstracts.

The Noter-up section will guide the reader to all supplementary articles or to critical surveys of each subject mentioned in the main work; this also applies to all abstracts. Non-subscribers to the main work will still find the Noter-up section of value, in that it is arranged alphabetically, and at a glance, information can be gained from the publication of all recent material on any particular subject. Consequently, the *Progress Volume* can be used independently.

Every article in the main volumes of *British Surgical Practice* has a Key Number, which appears at the commencement of each chapter and also at the top left-hand corner of every right-hand page. In order to ascertain whether there has been any recent advance in the particular subject to which reference is being made, the reader should merely turn to the appropriate Key Number which appears in the left-hand margin of the Noter-up section. He will there find either a note that no further references appear or information as to the type of new matter incorporated by way of article, survey or abstract. This is amplified by a brief outline of the content of the recent addition.

Subscribers who turn direct to the abstract section will find that here also the keyed arrangement has been followed.

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PART I—ORIGINAL ARTICLES

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INTRODUCTION

SURGICAL PROGRESS may take the form of modifications and improvements in well-established methods of treatment, or of entirely new techniques and original means of dealing with problems not hitherto amenable to surgery The present volume contains examples of both these forms of progress, and we are greatly indebted to our colleagues for their willing and generous collaboration in placing their experience at our disposal.

The more novel subjects which are much in the public eye are represented by Mr. Potter's informative and beautifully illustrated chapter on spontaneous intracranial haemorrhage, Mr Pyrah's article on ureteric transplantation, which we hope may be followed in due course by further reports of his experience in using the intestine for various purposes in urinary surgery; the article by Dr. Scurr and Dr. Organe on hypothermia, and Mr Hamilton's account of partial nephrectomy, an operation which when skilfully performed in properly selected cases must be regarded as a triumph of conservative surgery Mr. Sharrard's article has been included because we believe that it throws a flood of light on the interpretation of paralysis in poliomyelitis and has a direct bearing on the management of the disease. It illustrates one of the advantages of an annual progress volume in that some subjects can be dealt with at a length which would have been disproportionate in the original presentation of surgery as a whole Mr. Muir's method of treating rectal prolapse deserves to be regarded as an entirely new approach to an old problem; and the work of Mr. Patey and Dr. Thackray on parotitis breaks new ground as well as correcting previous misconceptions Mr. Chin's article on congenital deformities of the thorax and their treatment deals with a subject to which there has not been any previous reference in *British Surgical Practice.*

The remaining articles are of value because they help to bring up to date subjects which, though mentioned in the original volumes, must be re-described in the light of subsequent experience They are the interesting review of pancreatitis by Dr. Walter Mackenzie and Dr Leslie Willox of the University of Alberta, the chapter on melanoma by Cecil Lewis, recently appointed Professor of Surgery at Perth, Western Australia, the descriptions of the treatment of [illegible] by Mr [illegible] and of [illegible] cedures omitted from the earlier volumes and now described by Mr Barron. The order in which these contributions are mentioned is not to be regarded as an indication of their relative importance, for to grade them in this fashion would be well-nigh impossible. They are all valuable contributions to *British Surgical Practice*, but their relative value must vary according to the practice and interests of those who read them It is our hope that all surgeons may find something of interest in this volume.

E. ROCK CARLING
J PATERSON ROSS

BRAIN–SPONTANEOUS INTRACRANIAL HAEMORRHAGE

By JOHN M. POTTER, M A, M B, B.Chir., F.R C S.
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INTRODUCTION

In few other clinical problems can there be so much doubt and so little that is certain as in the case of intracranial haemorrhage which is not of traumatic origin Such evidence as there is concerning prognosis and the efficacy of various methods of treatment has been interpreted as supporting different viewpoints, and it is not surprising, therefore, that agreement should not yet have been reached concerning the place of surgery in the management of these cases Experience has chastened the more enthusiastic advocates of early surgical intervention, to the extent that the tendency now is more to try to protect the patient from further haemorrhage than to attempt heroic, but usually unrewarding, operations to stop bleeding that is already in progress. While it is believed that surgery may help these patients, by attention to lesions that are a likely source of recurrent haemorrhage, sufficient time has not yet passed to assess to what extent it does so.

The account that follows is intended more as a guide to general principles and to recent trends in the subject than as an attempt to give either a clear-cut, dogmatic policy or a review of the many differing (and confusing) practices that may be encountered

The particular leanings of individual physicians, who usually have an earlier responsibility than the surgeon for these cases, must inevitably be reflected in an account of any surgical series, and practical considerations, such as bed-space and operating time, will determine how much of this type of work a particular surgeon is able to undertake, for these often desperate cases are numerous, and the rewards are as yet unpredictable Moreover, it must be said that a certain skill and patience are required of the operator if the dangers of surgery are to compare favourably with those of conservative treatment—the dividing line between the two may yet prove to be finer than it is at present thought to be.

AETIOLOGY AND PATHOLOGY

Aneurysms

"Berry" aneurysms (as Sir James Collier aptly named them) are much the commonest lesions for which surgery may be considered in cases of spontaneous haemorrhage. The irregular, fusiform arterial dilatations that are associated with arteriosclerosis do not really concern us, and syphilitic aneurysms of the cerebral arteries were probably rare even when syphilis was common Mycotic aneurysms are also uncommon; they are usually small and situated at the periphery of the middle cerebral arterial tree; and the causative infection, chiefly subacute bacterial endocarditis, will generally have been recognized

Only the "berry" aneurysms will be considered further.

Origin and mechanism of rupture

There are two main views about the origin of these so-called congenital aneurysms. The first, largely due to Forbus (1930), is that they are, in fact, "acquired lesions based upon a fundamental predisposing factor in the form of a congenital arterial structural imperfection, a defect in the muscular coat, characteristically located at points of bifurcation". The persistent, saccular dilatation follows stretching and degeneration of the internal elastic lamina. The importance of this deficiency of the muscle has since been disputed, and to many the alternative theory of Padget (1944) is more acceptable. This suggests that aneurysms form at the sites of temporary embryonic arteries that have failed to undergo complete involution, and accounts for those aneurysms that do not apparently arise at bifurcations. These two theories may not be as incompatible as they at first appear, and in either case it seems likely that the actual aneurysm itself is a product of time.

There must also be complicated and scantily understood rheological factors concerned in the production of what may be conveniently considered as an area of "structural fatigue", and in the mechanics of the final stress that results in rupture—or, as some prefer to consider it, the gentler process of leaking or extravasation of blood. Such extravasation has been observed microscopically to have dissected the walls of aneurysm and artery in some cases. Coughing and straining figure sufficiently often, as initiating factors, in the histories of cases of subarachnoid haemorrhage for it to be impossible to disregard their possible relevance; but, in the majority of cases, the rupture is apparently more truly spontaneous. Hypertension does not seem to be appreciably more frequent in cases of ruptured aneurysm (Falconer, 1954). The site of rupture is usually the fundus of the aneurysm, but it is important, from the therapeutic standpoint, to note that it may sometimes be at the base.

In patients who survive a rupture, adhesions are formed in the immediate neighbourhood of the aneurysm, which thus becomes sealed off from the subarachnoid space. Subsequent haemorrhage, therefore, is often directly into the brain (Williams and his colleagues, 1955).

Incidence and age

It has been estimated that "berry" aneurysms of the cerebral arteries are present in 0·5–1·0 per cent of the general population, but these are necropsy figures which cover both ruptured aneurysms and those found incidentally.

The average age at which rupture occurs is about 45 years, and 80 per cent of cases are over 30 years of age (Falconer, 1954).

Sites

The majority of aneurysms are on, or close to, the anterior part of the circle of Willis, and the small proportion (about 15 per cent or less) that are in relation to the vertebral and basilar arteries are at present of surgical interest only rarely, and then as problems in differential diagnosis, when they are large enough to simulate neoplasms of the brain stem or cerebello-pontine angle. Peripherally situated aneurysms are rare.

In clinical practice it is convenient to recognize three main situations, each with some therapeutic significance. Aneurysms at the termination of the internal carotid artery, or in relation to its immediately adjacent branches, commonly the posterior communicating artery (Figs. 1 and 2), form the largest group (about 50 per cent); those related to the anterior cerebral or its communicating artery (rather more than 20 per cent) are next in frequency (Fig. 3), followed closely by those of the middle cerebral artery, usually at its first division (Fig. 4). In necropsy series the proportion of anterior communicating aneurysms is usually higher. This may be confirmation of their particular reputation for deadliness, or because they are sometimes difficult to see in arteriograms.

Aneurysms are multiple in 10 per cent or more of cases.



FIG. 1.—A left carotid arteriogram showing a small aneurysm, in a man aged 45, at the origin of the posterior communicating artery. The lesion had ruptured earlier; treatment was by common carotid artery ligation

Size

Nearly all Falconer's (1954) 148 consecutive aneurysms were less than 1·5 centimetres in diameter. The large aneurysms which produce focal pressure signs and radiographic changes of local bony erosion are rare; these enlarge slowly, lamellated thrombosis tends to occur within them, and their walls may thus thicken and later calcify (Fig 5). They seem less liable to rupture than the little aneurysms, but may do so. They were described at a time before routine arteriography had shown that the great majority of ruptured aneurysms were small and rarely produced focal signs other than a third cranial nerve palsy A small aneurysm is shown in Fig. 1, but they may rupture when even smaller than this.

Shape

While, typically, they are berry-like, lobulated aneurysms (Fig 3) may be seen, and also dumb-bell-shaped ones which may be due to the formation of a false aneurysmal sac following a rupture that has been well localized.

Angiomatous malformations (synonym—angiomas)

These lesions (illustrated in Figs. 6–8 and 11–14) may be considered second in surgical importance, although, as a cause of haemorrhage, they are encountered very much less frequently than aneurysms. They tend to rupture earlier in life, and are probably the chief cause of cerebral apoplexy in childhood (Figs. 11 and 12).



(a)



(b)



(c)

[illegible]

They are not neoplasms, but developmental anomalies (vascular "hamartomas") that act as areas of circulatory perversion, for almost all of them are seen on angiography to have *abnormal arteriovenous connexions.* The total lesion varies in size from a small "telangiectasis" to a huge "serpentine" in "racemose angioma" (Figs. 6 and 7). The well-known physiological effects of arteriovenous fistulae on the vessels concerned, and on the circulation in general, vary according to the size and duration of the shunts; but the general circulatory effects are much less frequently seen than in the similar anomalies that are found, more rarely, in the limbs.

They may be situated on the surface or deeply in the brain, sometimes projecting into the ventricular cavities. Thus, they are more liable to bleed into the brain substance (Figs. 6, 11 and 12) or ventricle than directly into the subarachnoid space. It is a general impression that this form of haemorrhage is less severe than that from an aneurysm—indeed, the vessel concerned is likely to be smaller. It is also believed that it is the smaller malformations that are the more likely to rupture (Figs. 11 and 12).

Haemorrhage from unknown cause

In approximately 20 per cent of clinical cases of spontaneous intracranial haemorrhage (other than those due to hypertension), no cause can be found, even when bilateral carotid angiography has been performed. A subsequent autopsy may reveal an aneurysm on the vertebral-basilar system, or sometimes one anteriorly that has not shown on the carotid arteriograms. An aneurysm may occasionally clot after rupturing; and it is believed also that small angiomatous malformations may sometimes destroy themselves by haemorrhage, for many of these idopathic apoplexies attack young people.

Hypertensive cerebro-vascular disease

This is the commonest single cause of spontaneous haemorrhage; it is also by far the most lethal. Fifty per cent of Professor Dorothy Russell's (1954) necropsy cases were in this group (the majority suffered from "benign" hypertension), in contrast to 20 per cent due to aneurysms and 4·5 per cent which had angiomatous malformations. The well-known descriptions of this classical apoplexy will not be re-stated here.

Surgery has usually little to offer. The stroke is by no means always fatal; spontaneous recovery to a variable degree may take place, and this may occasionally be assisted beneficially by the surgical evacuation of a clot that is refractory to the natural process of absorption. The patient may then survive a year or two before there is a similar, or an associated, catastrophe that is usually fatal.

Unusual causes

Blood diseases, notably *acute leukaemia,* head this list, and are followed in order of frequency by *intracranial neoplasms.* In spite of common belief to the contrary, haemorrhage from a brain tumour as a clinical event is unusual; and it is rare even for that true vascular neoplasm, the cerebellar haemangioblastoma, to bleed

A tuberculoma, or the small tubercles in tuberculous meningitis, may occasionally erode blood vessels and cause haemorrhage; and polyarteritis nodosa is probably one of the rarest causes, not having been encountered at all in Dorothy Russell's (1954) 461 necropsies of cases of spontaneous intracranial haemorrhage.

CLINICAL DIAGNOSIS

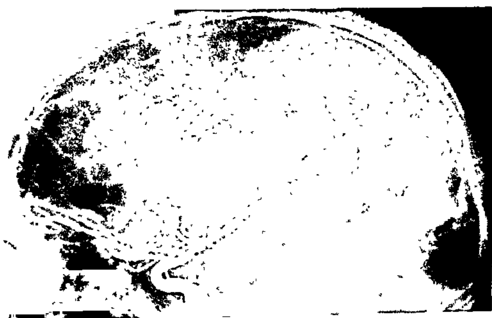
Diagnosis of intracranial haemorrhage

Typically, there is severe headache of abrupt onset, vomiting is common, and there is usually, but not always, loss of consciousness, sometimes an epileptic fit occurs.

A confirmatory *lumbar puncture* should always be performed; the pressure is



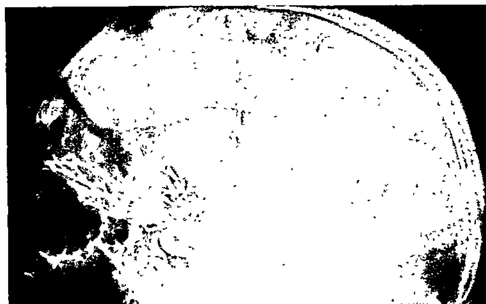
(a)



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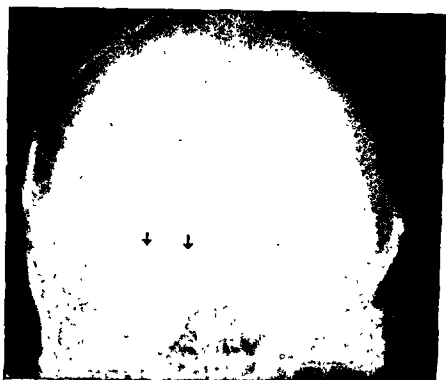


(c)



(d)

Fig. 3—A multilocular aneurysm of the anterior communicating artery, filled in a left carotid arteriogram; (a) antero-posterior and (b) lateral views before operation;



(*a*)



(*b*)

Fig. 4—A right middle cerebral artery aneurysm which caused a fatal subarachnoid haemorrhage in a man aged 26. Note, in the antero-posterior view (*a*), the gross irregularity of the first part of the middle cerebral artery (between the arrows) due to spasm. At autopsy, this portion of the artery was of normal, regular calibre, but was stained yellow by blood pigment.

recorded, and the fluid in the manometer withdrawn so that the degree of blood-staining can be ascertained. The pressure is usually high, but on rare occasions will be low or even negative, and the fluid may need to be aspirated. In subarachnoid haemorrhage, the appearance of blood in the lumbar sac is sometimes delayed for a few hours; and in strictly intracerebral haemorrhage, it may not be found at all Within a few days, or earlier, the supernatant fluid becomes yellow and, according to the size of the haemorrhage, will persist so for about 2 weeks or more; often until well after the clinical signs have disappeared—an important diagnostic point, especially in mild cases.

Subarachnoid haemorrhage

When the leptomeninges are primarily affected, neck stiffness and a positive Kernig sign usually supervene, although sometimes not for several hours. The patient is frequently confused, and may complain bitterly of pain in the head and neck. The pupils will be variable, the tendon reflexes usually depressed, and both plantar responses are often extensor. There are, in fact, typically no focal neurological signs

There is usually some fever for a day or two, and the urine may initially contain both albumen and sugar, which clear later. Sometimes, sciatic pain occurs, presumably as an irritative effect of the blood that has sedimented in the lumbar sac.

Intracerebral haemorrhage

Here, there will often be neurological signs appropriate to the area of the brain involved. The frontal and temporal lobes are most commonly affected by ruptured aneurysms, but when in the former site a clot may give no obvious signs unless it is placed sufficiently far back to induce a hemiparesis. A "homonymous" hemianopia or upper quadrant visual field defect should be specially sought as evidence of a haemorrhage within the temporal lobe. Bleeding may, of course, be both intracerebral and subarachnoid.

Occasionally, a spontaneous intracerebral haemorrhage will proceed insidiously and mimic completely a cerebral tumour. More commonly, it remains concealed behind the more dramatic picture of subarachnoid bleeding.

Diagnosis of the causative lesion

Aneurysms

Headache does not usually precede rupture, but may do so for some days; it is then often situated in one frontal region or in relation to the eye. The aneurysm otherwise gives little clinical evidence of its presence or its situation unless it is a large one, or is situated in relation to the oculomotor nerve, a palsy of which is a reliable localizing sign. With ruptured anterior communicating artery aneurysms, a peculiar type of stupor may be seen, in which there is a remarkable slowing of the responses to questions, commands and painful stimuli This torpor may be an incomplete version of "akinetic mutism", which may also occur. With it, unilateral or bilateral grasp reflexes may be observed.

Examination of the fundus oculi may disclose a variety of retinal haemorrhages, especially if an aneurysm has ruptured close to the optic nerve sheath; in particular, there may be seen the large subhyaloid type. A unilateral subhyaloid haemorrhage often indicates that the ruptured aneurysm is on that side. A hemiparesis, however, is not a reliable lateralizing sign, for it is as often on the same side as contralateral to the lesion (Falconer, 1951)

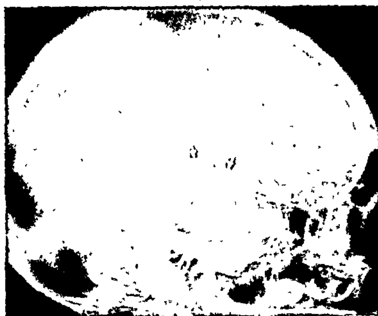
The uncommon, large aneurysms, which seem less liable to rupture, may cause focal neurological and radiological (*see* p. 16) signs peculiar to their localities; and readers may wish to read Meadows's (1951) excellent review, and Jefferson's classical papers on those that involve the optic nerves, chiasm and tracts (1937), and on the



(a)



(b)



(c)



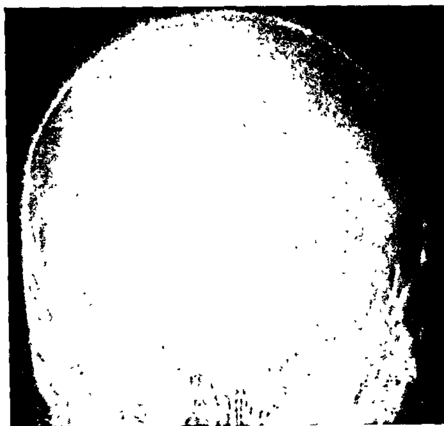
(d)



(e)

Fi- ...

pain in the first division of the right trigeminal nerve, and dementia The aneurysm had never ruptured



(a)

Cerebral embolism

This produces usually an even more abrupt stroke than does haemorrhage, but almost always is there evidence of heart disease, most frequently affecting the mitral valve.

Thrombosis

Here, the effects are typically less rapid, and also less dramatic, unless an area of great strategic importance (such as that of the posterior inferior cerebellar artery) is involved. But cerebral thrombosis is a clinical diagnosis that is now less readily accepted, because small, leaking intracerebral haemorrhages may be quite mild in their effects, and the blood may not reach the lumbar sac at all—or not in a quantity acceptable for a firm opinion that it is other than a result of the puncture. Moreover, the time relations that, it is often taught, distinguish between embolism, haemorrhage and thrombosis are of limited validity. It is also believed that cerebral infarction can occur from circulatory insufficiency without thrombosis in areas where the arteries are narrowed by organic changes or spasm



(c)

FIG 7—An extensive inoperable [illegible]
cerebral hemis[illegible]
that is fed by [illegible]

[illegible] man, now aged 60, who has had migraine for 40 years and epilepsy for more than 20

Epilepsy

That a fit has occurred may be suspected afterwards, when the patient has returned fairly rapidly to normal and the cerebro-spinal fluid is clear. Headache may, however, persist for some hours. A bitten tongue, a past history of fits, and an electroencephalogram showing characteristic changes may be found; but it should be remembered that a fit sometimes accompanies the onset of a haemorrhage. A *Stokes-Adams attack* may cause rapid loss of consciousness and convulsions.

"Ophthalmoplegic migraine"

This strange affliction produces headache and a temporary third cranial nerve palsy. The same picture may be caused by a supraclinoid aneurysm enlarging suddenly or affecting the oculomotor nerve in some way other than by actually rupturing. No organic abnormality is seen at carotid angiography, and there may have been previous attacks, often dating from childhood.

Acute meningitis.—Acute meningitis sometimes fulminates, but lumbar puncture yields purulent instead of bloody fluid.

Intracranial tumour.—This may cause acute headache due to a temporary exacerbation of intracranial pressure, and there may also be neck stiffness associated with descent of the brain stem, particularly in tumours of the posterior cranial fossa. The history and neurological examination will usually establish the diagnosis, but it will be unwise to perform lumbar puncture.

It will thus be seen that, except in the case of tumour, the question of differential diagnosis is largely answered by lumbar puncture.

RADIOLOGICAL DIAGNOSIS

Plain x-rays

The skull should always be examined radiologically for calcification in the wall of an aneurysm (Fig. 5) or in an angiomatous malformation (Fig. 8), but these signs are uncommon in cases of haemorrhage. If the pineal body is calcified, it may show some shift laterally indicating a sizeable clot.

Large aneurysms, particularly those originating in the cavernous sinus ("sub-clinoid"), may cause local bony erosion of the lesser sphenoidal wing (Fig. 5e), especially in the region of the superior orbital fissure and the adjacent part of the optic foramen, and of the anterior clinoid process itself.

Angiography

By means of angiography, precision is achieved in the diagnosis of aneurysms and angiomatous malformations, the localized haematomas they may produce, and of the spastic changes that often occur in the adjacent arteries during the acute stage of the illness. This method is therefore responsible to a large degree for the increased surgical interest in these lesions and for almost all that is rational in their present-day management.

The technique will not be described; the percutaneous method of puncturing one of the carotid arteries in the neck has now almost entirely superseded the tiresome "open" method, and, in skilled hands, it is a reasonably safe procedure.

Provided facilities are available, all cases of spontaneous intracranial haemorrhage that are not clearly of hypertensive origin should be investigated by this method. If there is a history of asthma or other allergic states, some prefer to use Thorotrast instead of one of the diodone preparations, but, as the long-term effects of the radio-activity of the former may be undesirable, its use is usually restricted to older patients, and the need for it is infrequent.

When to perform angiography

Until the cause of the haemorrhage is known, and the lesion clearly delineated, no specific treatment can be employed; it was this reasoning that led to the practice of

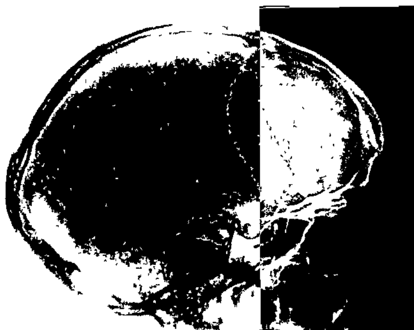


FIG 8 —The arrow indicates faint, mottled calcification in a small part only of a large right frontal angiomatous malformation in a man who started to have generalized epileptic fits at the age of 19.

doing this investigation as soon after the haemorrhage as possible. However, such complications as may attend it, for example, a general worsening of the condition of a patient who is already seriously ill or the appearance of fresh abnormalities such as hemiparesis, are understandably greater if an aneurysm is still bleeding; and since few neurosurgeons now advocate very early operation, it has become usual for angiography to be carried out about a week or even longer after the onset of haemorrhage

The likely side is first examined, and, if this does not show an abnormality, the other internal carotid is punctured, but it is better not to do this on the same day. In any case, both sides are usually examined since there may be bilateral aneurysms The standard views are antero-posterior and lateral, and an oblique one (Fig. 2*c*) is usually necessary in order to exclude an aneurysm that is obscured by adjacent vessels Phlebograms are taken, at approximately 2 and 6 seconds after the arteriographic phase, in order to show the later venous drainage of any angiomatous malformation If an aneurysm is shown, the opposite common carotid artery is compressed and another antero-posterior arteriogram taken in order to demonstrate the presence or absence of a free anastomosis across the anterior communicating artery (Fig. 2*b*)

Vertebral angiography.—This is not done routinely, but may be required for a specific purpose, such as the demonstration of any contribution that the branches of the basilar artery may be making to an angiomatous malformation (Fig. 7*c*), and thus to help in the assessment of its operability. Aneurysms of the vertebral-basilar system are uncommon and only rarely operable, but a few of the even rarer angiomatous malformations of the cerebellum may sometimes be amenable to surgery (Logue and Monckton, 1954).

Considerable experience is needed for the recognition of some small aneurysms, and the arteriograms reproduced in Figs 1–5 all show obvious ones. A common mistake is for the novice to interpret as an aneurysm the dense and well-defined circular shadow of an artery seen end-on An aneurysm is not usually so regularly circular, and never so relatively opaque unless superimposed on other arteries.

PROGNOSIS

It is always difficult to tell the natural prognosis of an individual case; a mild initial haemorrhage may be followed shortly by a fatal one, and a severely ill patient may recover completely. The best possible statistical series, when it appears, will give little comfort to any patient's relatives.

Aneurysms

The immediate prognosis

For a patient bleeding for the first time from a ruptured aneurysm, the outlook is to some extent adversely influenced by three chief factors: (1) deep coma which usually implies either a severe haemorrhage or that a strategic part of the brain is involved; (2) a patient over 50 years of age; and (3) by any pre-existing hypertension. Such hypertension is probably not significantly more frequent in cases of ruptured aneurysm, but a temporary increase in the blood pressure may occur secondarily to the haemorrhage itself. Persistence of orbito-frontal pain is often a warning that further bleeding will occur.

It appears that rather less than 50 per cent of patients die during their first illness from a ruptured aneurysm Over this period, there may be several episodes of bleeding, but probably about two-thirds of this group are out of the reach of effective surgery, except in a few fortunate cases.

Late prognosis

It is not yet certain what proportion of those who survive the first illness die subsequently from recurrent haemorrhage, or how long this takes to happen. Probably 20 per cent do so, but it may be considerably more. About half these deaths occur within the subsequent 6 months, and, for some reason that is not clear, women seem at least twice as liable as men to die from recurrent haemorrhage (Walton, 1952).

It may be inferred from these figures that there must be a death-rate significant[illegible] less than 20 per cent in patients who have been operated upon—including those wh[illegible] bleed fatally later despite an operation—if we are to believe that a prophylacti[illegible] operation is an improvement upon natural processes The remarkably low mortality, reported by Norlén and Olivecrona (1953), of only 2 deaths in 63 operations for direct attacks on aneurysms in a 2-year period, has been a considerable stimulus to this type of surgery. Some of these patients may yet suffer further episodes of bleeding, but it is hard to believe that such skilful surgery has not something important to offer those who have survived a haemorrhage (such were those selected), each of whom would otherwise appear to have at least a one-in-five chance of a premature death.

Morbidity

Ill-effects, short of death, occur in about one-third of those surviving their first haemorrhage from an aneurysm, but they may also follow a prophylactic operation. The relative dangers with the differently sited aneurysms have not yet been satisfactorily assessed. The anterior communicating artery lesions have an especially evil reputation for producing dementia, while those of the middle cerebral artery are liable to result in hemiplegia with, or without, dysphasia, from which recovery may be incomplete. Diplopia from a partially recovered third-nerve palsy may persist after rupture of an aneurysm near the carotid termination, and it is one of Nature's paradoxes that this should not be possible until some recovery from the ptosis allows the lid to open. Other possible sequelae include· epilepsy and headache, and psychological disturbances, both organic and due to anxiety, which are similar to those that may follow severe head injuries, and which may be aggravated by advising or allowing needless invalidism.

Angiomatous malformations

When these lesions bleed, the prognosis both for immediate and later survival appears to be considerably better than is the case with a ruptured aneurysm Many

examples have been described of long periods (20 years or more) between bouts of haemorrhage, and patients are known who have weathered up to twelve episodes.

If the causative lesion can be completely removed, the prognosis as regards haemorrhage (but not necessarily epilepsy, on account of the scar that remains) should be good, although one or two cases have been met in which a fatal, recurrent haemorrhage has occurred in spite of what was thought to have been a radical removal.

It has been suggested that radiotherapy may improve the long-term prospects for patients with inoperable lesions (Potter, 1955).

Morbidity

Paralytic and mental changes may result also from rupture of angiomatous malformations, depending somewhat on their site and on the severity of the haemorrhage. Again, the lesser fury of these bleeding episodes is a favourable factor. Epilepsy is often a natural accompaniment of these lesions before they rupture, but it may start only after a haemorrhage (or an operation).

TREATMENT OF INTRACRANIAL ANEURYSMS

General management

The immediate treatment of a case of intracranial haemorrhage will usually be that of a comatose patient, and this has been described in detail elsewhere with reference to head injuries (Botterell, 1948a). The maintenance of a free airway is perhaps the most important point to stress. It is as well to empty the rectum with a plain enema soon after admission; and to give liquid paraffin, ½ fluid ounce, twice daily in order to prevent constipation and the necessity for any straining at stool later.

Lumbar puncture is probably best avoided after the initial diagnostic one unless there is a good indication, such as the desire to know whether haemorrhage has recurred. Its overall therapeutic value is doubtful, although it may relieve headache temporarily It may, however, be dangerous: the risk of precipitating renewed bleeding is probably small; but sudden or delayed death from medullary or mesencephalic "coning" may sometimes follow, especially if there is a large intracerebral clot, the presence of which may not be recognized in the earlier stages of the illness.

Headache may be agonizing, and aspirin-phenacetin-codeine mixtures by mouth or rectum often give little relief, but rectal infusions of 50 per cent magnesium sulphate may be helpful. Before resorting to morphine or pethidine, it should be realized that the added vomiting that these drugs are liable to encourage may induce further haemorrhage. Heroin does not have this great disadvantage to anything like the same degree.

Any essential or "malignant" hypertension should probably be treated with the appropriate "hypotensive" drugs, unless the patient is elderly In theory, it is as well to wait for about 2 weeks before doing this for fear of risking further insufficiency of blood to those areas whose nutrient arteries may be in spasm.

Following a subarachnoid haemorrhage, whether or not there has been an operation, a period of about a month in bed should be observed, and the patient's return to normal activity gradual. It must be admitted that the rationale for this is somewhat insecure; for just what it is that imposes a strain on the aneurysm is not clear As with head injury cases, it is important to be sympathetic, but not to encourage anything that might result in permanent invalidism.

When to operate

As has been said earlier, the results of any operation (carotid ligation or direct attack) that may be undertaken during the early stages of the illness are probably no better than those of expectant treatment. The chief reason for this is now believed by many to be the abnormal propensity towards spasm that exists in the cerebral arteries

in the vicinity of a recently ruptured aneurysm. The resulting irregularity of the arterial lumen has been demonstrated clearly in arteriograms that have been performed early (Fig. 4), and this radiological picture is an extremely uncommon one on other occasions Arterial spasm has also been described by those who have observed it directly at operation; and the evidence of the case illustrated in Fig 4 suggests that it may well be a direct effect of the extravasated blood, or of its breakdown products on the smooth muscle. If this is so, the sympathetic nervous system is unlikely to be of much relevance.

Operation, therefore, is now often postponed until about 2 or 3 weeks after the onset of haemorrhage Assessing the optimum time may be extremely difficult, since renewed and fatal haemorrhage may supervene while one is awaiting further improvement in the patient Recovery from the mental disturbance usually indicates that it is reasonably safe to proceed with operation. Cases must, of course, be judged individually, and it may sometimes be felt that an operation ought to be performed during the early stages of a desperate case that seems certain to end fatally unless the bleeding can be controlled In those few cases where the clinical evidence is sufficient to localize the lesion, it is possible to ligate a carotid artery or evacuate a temporal lobe clot without prior resort to angiography, but this is not usually desirable.

Patients whose lives are endangered by localized but expanding haematomas demand special consideration which is accorded at the end of this chapter.

Carotid artery ligation in the neck

Uses

This Hunterian ligation is still, for many surgeons, the standard surgical procedure for most aneurysms of the *internal carotid artery* (especially the infraclinoid lesions) and for those in the immediate neighbourhood of its termination. It is less commonl used to cause a fall in pressure in aneurysms that are situated more peripherally o the carotid tree, such as those on the *middle cerebral artery*. An anterior communicating artery aneurysm, however, usually enjoys a free and close communication with either carotid and does not seem to be very suitable for this type of treatment, although a similar principle is employed by Logue when he clips the anterior cerebral artery proximally (*vide infra*)

Apart from the occurrence of haemorrhage, it should be mentioned also that carotid ligation is an excellent operation for those unruptured carotid aneurysms that cause pain, bony erosion and disturbance to local structures

The efficacy of carotid ligation

Those with experience of this operation (for example, Jefferson, 1952; Johnson, 1952) believe that it reduces the chances of further haemorrhage, but no one accepts that the protection is likely to be absolute The degree of prophylaxis is still unknown, but there is satisfactory evidence that the pressure falls distally in the carotid system, and that this fall is maintained for a period that is considered sufficiently long to b useful (Bakay and Sweet, 1953) Even an aneurysm at the first bifurcation of the middl cerebral artery may be observed at operation to reduce or cease its pulsation wher the common carotid artery is occluded digitally in the neck. Cure by thrombosis is known to have followed ligation, but the proportion of cases in which this fortunate event happens is again unknown.

Dangers and precautions

Sixteen years ago, Schorstein (1940) showed that hemiplegia and death occur very much more frequently if, at the time of carotid ligation, the patient is already ill as the result of recent haemorrhage. The importance of the timing of this operation has been insufficiently appreciated by those who have emphasized the dangers of the operation *per se*. Surrounding the whole subject of carotid ligature there is also a

vague atmosphere of disrepute which is possibly a relic of pre-Listerian days, when the procedure was used more heroically for haemorrhage that was often secondary to sepsis, or in connexion with severe operations for malignant conditions. The operation is a relatively safe one if undertaken after the initial two-week or three-week period, by which time the patient is usually reasonably well.

Immediate hemiplegia.—However, some individuals, owing probably to an anomalous circle of Willis, are immediately intolerant of the procedure. In all cases, therefore, a trial period of about 30 minutes should be observed during which a Crile's clamp is fully applied to the artery, and the patient tested carefully at intervals for evidence of a developing hemiplegia. If this occurs, it is unsafe to ligate. Digital compression of the common carotid artery against Chassaignac's (carotid) tubercle is unreliable in ensuring complete occlusion. Some American surgeons practise this pre-operatively for periods of increasing duration in the hope that the collateral circulation may thereby be the better prepared for its task The method may also be tried in order to prepare for a second attempt a patient who is intolerant initially

Delayed hemiplegia.—This is the dreaded complication in a few cases. It is largely unpredictable and occurs some hours or days after operation Its mechanism is disputed, for most cases do not die and reveal for certain the cause. Embolism and thrombosis have been popular explanations, but it is known that cerebral infarction may occur without any obvious organic occlusion of the arteries; it is felt by many that such factors as arterial spasm and a fall in the systemic blood pressure may sometimes be the cause, either individually or in combination with the relative deprivation of blood supply already effected by the ligation.

Pre-operative angiographic evidence of a good anastomosis across the anterior communicating artery (the "cross-circulation test") may be comforting, but it cannot be relied upon to mean that all will be well; conversely, it is possible to ligate the common carotid artery without ill-effect when there is apparently no anterior communicating artery at all—as judged by this test The electroencephalogram is also unhelpful in predicting complications (Potter and Taylor, 1955). Attempts have been made to formulate rules for ligation according to the degree of the fall in intra-arterial pressure when this is measured distal to the clamp, but no notable conclusions have yet emerged. Measures such as the plication of the artery wall and the use of metal or fascial bands have been designed to prevent damage to the carotid intima, which, the protagonists of these methods believe, favours the formation of a loose or spreading thrombus. Few surgeons believe that block or section of the cervical sympathetic chain diminishes the incidence of complications; and the suggestion that anticoagulant drugs should be used finds no favour with those who feel that the sound healing of the hole in the aneurysm is the primary objective.

If the hemiplegia occurs early and is recognized promptly or before it is complete, and if the ligatures can be removed with the utmost rapidity, then recovery may occur with astonishing suddenness It is for this reason that division of the artery after ligation is not advised. The ligatures should not of course be undone if there is already thrombosis beyond them, and a strong warning must be given that disastrous effects may attend the flooding of an already infarcted area of brain with a fresh torrent of arterial blood When in doubt, it is better to hope for spontaneous recovery, and to some extent this will frequently occur. It is wise to keep the foot of the bed raised post-operatively, for the upright posture has several times been noted to have induced or aggravated a hemiplegia, which improved when the patient lay down.

Common versus internal carotid ligation

Two opposing objects are in view when carotid ligation is under consideration in these cases. On the one hand, the stresses operating upon the aneurysm need to be reduced as much as possible, and on the other, an adequate supply of blood must be preserved for the brain.

Ligation of the common artery is generally considered safer than that of th[illegible] internal carotid. Internal carotid ligation is nearer to the aneurysm, however, an[illegible] cuts out any contribution from the external carotid. A compromise is sometime[illegible] effected by tying first the common carotid and, a week or two later, the internal hoping for some collateral circulation development meanwhile.

However, since the degree of protection seems as much in doubt in one method a[illegible] in another, common carotid ligation alone may be recommended to those who wis[illegible] for arbitration in this matter.

The technique of common carotid ligation

No special merit is claimed for this particular procedure, except that it is straight forward and has given results that compare favourably with those of more elaborat[illegible] and time-consuming techniques.

Narcosis with Omnopon, $\frac{1}{3}$ grain, Scopolamine, $\frac{1}{150}$ grain, and Seconal, $1\frac{1}{2}$–3 grains given three-quarters of an hour beforehand, makes the operation an undisturbin[illegible] experience for the patient, who can usually co-operate satisfactorily during th[illegible] important neurological examinations, the first of which should be carried out befor[illegible] the operation is started. Local analgesia ($\frac{1}{2}$ or 1 per cent Xylocaine) should be withou[illegible] adrenaline, which may cause a rise in blood pressure dangerous to the integrity of th[illegible] aneurysm.

A "half-collar" incision is made in a convenient skin crease. The artery is exposed conventionally, either above or below the omo-hyoid, and a length of 2–3 centimetres is cleared within its sheath. Two strong, waxed, twisted-silk ligatures are placed in position, above and below, but are not tied. The rubber-covered Crile clamp is then screwed on between the ligatures, and the 30-minute period of trial occlusion begins. If no evidence of a hemiplegia occurs (equivocal plantar responses and other doubtful signs should be disregarded), the two ligatures are tied before the clamp is removed. This leaves a collapsed length of artery of about a centimetre between the two ligatures, whose ends are left conveniently long in case their rapid removal becomes necessary later. This spaced, double ligation is a precaution against the reconstitution of the arterial lumen that sometimes follows a single ligature. The platysma is closed with catgut, and the skin with Michel's clips.

It should be added that this operation is not always a straightforward one, particularly in patients with short, thick necks. Recent carotid arteriography by percutaneous puncture in the vicinity may have caused some extravasation of blood, making the identification of the deeper structures a little more difficult; and the artery itself is frequently stained yellow within its sheath. In the early days of arteriography by "open" operation, carotid ligation was usually performed at the same time, immediately after the aneurysm had been demonstrated radiologically. [illegible] structures, particularly the internal jugular vein, may have become [illegible] to the artery and its sheath.

Carotid ligation for certain intracranial aneurysms is by no means outmoded; it has the great advantage of being within the competence of all surgeons, and is therefore likely to die hard. The difficulties that arise in connexion with the operation, however, should be appreciated, and they have been discussed in detail. The operations that follow are of a more specialized nature, and will be dealt with more briefly.

Direct attack on the aneurysm

The information afforded by carotid arteriography, the encouraging operation results already mentioned, the coming of controlled arterial hypotension, some misgivings about the effectiveness of carotid ligation, and, above all perhaps, the

feeling that the cure of such a treacherous lesion is at least possible—all have combined to produce an access of enthusiasm for direct operations on the aneurysm itself.

Indications for direct attack cannot yet be given, as the decision often depends on the individual surgeon's experience and estimation of his ability to deal with any particular aneurysm. It is felt that the patient or his relatives, provided they are adequately intelligent, should share with the physician and surgeon some of the responsibility for what is to be done in a difficult case. The issue is likely to be the choice between the relative safety, but uncertain value, of carotid ligation, and the more dangerous, direct attack that offers a better chance of a lasting cure; and if carotid ligation is preferred, who is yet to say that this is wrong? It is unfair, at present, to expect a surgeon always to be able to give the dogmatic advice that is so often possible in other surgical problems; although in most cases he will have definite guidance to offer

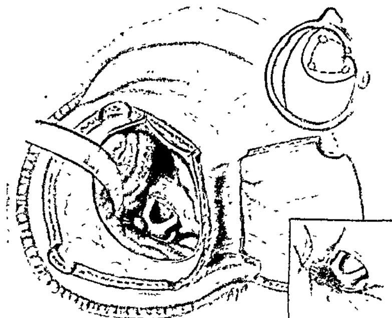


FIG 9 —The exposure of an aneurysm of the anterior communicating artery, which was wrapped with muscle (inset)

Routes of exploration

The operation is usually exploratory, for the arteriogram is likely only to suggest what it may be possible to accomplish when the aneurysm is reached

Aneurysms on and near the anterior communicating artery are usually explored; those of the middle cerebral artery often so (particularly when the cerebral hemisphere is the non-dominant one), but only some of those around the carotid termination are deemed more suitable for direct attack than for carotid ligation The individual surgeon's selection is encountered particularly in this last group

Anterior communicating artery.—This artery is approached through a frontal flap as for a pituitary operation (Fig 9) It is exposed by elevating the frontal lobe (preferably the right in a right-handed patient), entering the chiasmatic cistern, tearing gently through the pia-arachnoid, and, if necessary, sucking away a little brain in the immediate vicinity of the aneurysm When the aneurysm projects upwards and backwards, it [illegible]
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superior cerebral veins, but these complications may also result from the first approach, although they are often only temporary.

Middle cerebral artery.—The artery may be approached by a similar sort of flap, or through a [illegible] which is opened medially along [illegible] 10).

End of the [illegible] artery.—This is situated more medially, and to expose its supraclinoid aneurysms the arachnoid need not be divided until later in the approach. By retracting the pole of the temporal lobe backwards (after dividing the spheno-parietal sinus tributaries), a good view is obtained of the posterior communicating artery and the closely related oculomotor nerve.

Clipping, ligation and "trapping"

Clipping.—Having exposed the aneurysm and its immediately related arteries, it is only then possible to decide what best can be done. Ideally, one hopes for a well-defined, narrow stalk or neck across which a *silver clip* can be applied without damaging or kinking unduly the nearby arteries. Unfortunately, this is not the usual state of affairs, and an aneurysm with a clear "arteriographic neck", that is, when viewed indirectly and from within, may prove an ugly, sessile object when observed directly and externally; and "base" is probably a better term than "neck". However, a clip (or clips) may still be applied to the base, and several, larger and more suitable than those of Cushing, have now been designed to meet various predicaments. The chief object is to exclude the fundus of the sac, for that is the usual, but not invariable, site of rupture.

Ligation.—Sometimes a ligature is more suitable than clips (Fig. 10), but it may be advisable to tighten this only incompletely if it looks like kinking adjacent arteries. During these manoeuvres, carotid compression may assist in reducing the tension

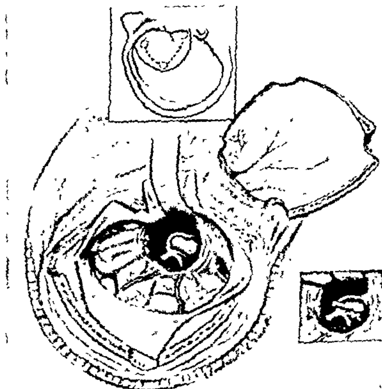


FIG. 10.—Operation on a right middle cerebral artery aneurysm, which was partially ligated at its neck and then wrapped with muscle. One main middle cerebral branch remains unclipped. The patient suffered no disability, and the [illegible] fill in a subsequent arteriogram

within the aneurysm, or the artery may have been exposed in the neck and surrounded with a tape as a precaution in the case of middle cerebral and internal carotid aneurysms.

"Trapping."—When an aneurysm is "trapped", a clip is applied to the artery on either side of it, but this may only be done if the artery concerned can be occluded with safety. The opportunities are therefore limited.

Rupture during exposure.—If an aneurysm ruptures during its exposure, the outcome is immediately prejudiced. Artificial hypotension has helped to mitigate the immediate difficulties, and prompt carotid occlusion in the neck often decreases the flow. It may be possible to get the collapsed aneurysm and its torrent into the sucker, and then to [illegible]

his colleagues (1956) have operated early on a few ruptured aneurysms, using hypothermia and occluding temporarily both carotid, and sometimes also both vertebral, arteries; but they are rightly cautious in their initial belief in the advantages that this technique appears to offer.

Spasm during dissection.—In order to counteract any spasm during dissection of the aneurysm, some surgeons apply papaverine sulphate (2·5 per cent) directly to the walls of the neighbouring arteries

Packing with muscle

This is another method of uncertain value. Some employ it in preference to a difficult clipping procedure, especially for anterior communicating artery aneurysms (Fig. 9); whilst others, having reason to doubt its efficacy, regard it as a method of despair, and point to its obvious imperfections. Its advocates believe that it helps to strengthen the wall of the aneurysm by creating an additional fibrous tissue layer. To the suggestion that there are better fibroblastic agents than muscle, it can be replied that too much fibrosis might be harmful to adjacent arteries.

The muscle is usually taken from the temporalis, and is beaten into a flat sheet which is wrapped as completely as possible around the aneurysm. Aneurysms that have been clipped or ligated may be reinforced in this way (Fig 10).

Clipping the anterior cerebral artery proximally

For aneurysms of the anterior cerebral and its communicating artery, Logue (1955) has tried, and recently reported favourably on, the effect of formally clipping the anterior cerebral artery near its origin, without disturbing the region of the aneurysm. This can only logically be done when the aneurysm fills predominantly from one carotid; but, at the same time, blood must also be able to cross the midline anteriorly. This is but a variant of the problem of the opposing interests of brain nourishment and aneurysm therapy, mentioned already in connexion with carotid ligation. Further time is needed to see whether the operative mortality of 13·5 per cent in 37 cases is an improvement on that resulting from other methods. Logue, who does this operation as early as the patient is conscious, found that in a control series, of 36 cases not operated upon, 44·4 per cent died.

Summary of the treatment of aneurysms

Anterior communicating aneurysms

Direct attack; clipping or ligature if possible, otherwise packing with muscle. Or clipping the anterior cerebral artery proximally.

Middle cerebral aneurysms

Either direct attack or carotid ligation. The latter especially when the speech-dominant side is concerned.

Aneurysms of the internal carotid and near its termination

Carotid ligation. Direct attack in selected cases.

Multiple aneurysms

No surgical treatment unless it is certain which aneurysm has bled; in which case, a direct attack is preferable if this is feasible.

TREATMENT OF ANGIOMATOUS MALFORMATIONS

Considerations regarding operation

The precise information that angiography gives and advances in neurosurgical technique have both stimulated interest also in the surgical excision of many of these lesions. Quite large ones can be removed without mortality—a feat declared by Harvey Cushing less than 30 years ago to be "unthinkable".

Nevertheless, it must always be asked whether this is the right treatment for an individual case; for, even more remarkable than any surgical results yet published are the numerous instances of long-term survivals, often with little or no disability, that have occurred in patients who have had no treatment other than, say, phenobarbitone for the mitigation of epilepsy. These malformations differ from "berry" aneurysms in the important respect that the haemorrhages that they may produce are usually milder and less of a threat to life There is not therefore quite the same feeling that a radical approach is necessary, and any prophylactic operation must be correspondingly justified.

It has been suggested that mental deterioration occurs eventually in a large proportion of cases, and that this is a further reason for a preventative operation. This view and its implications have not yet been substantiated and the possibility of dementia will not therefore be introduced here as an influencing factor.

Ideally, we should like to be able to excise a malformation completely, so that there is *no danger of further haemorrhage, no future epilepsy, and no increased physical disability.*

Protection against further haemorrhage

Nothing short of complete excision will guarantee this. Cases, such as that of Gillingham (1953), have been reported where fatal haemorrhage has followed a partial removal. Indeed, this has also been known to happen even after an excision that has apparently been complete. Naked-eye inspection at operation is not therefore infallible; and a few small abnormal vessels may be left behind (Fig. 11).

Carotid ligation, or the tying of arteries nearer to the malformation, has no more than a temporary effect before collateral channels open up, and there seems to be no good indication for this procedure, either from a theoretical standpoint or in the light of experience of cases where it has been carried out.

Epilepsy

The brain scar that results from an operation may prove to be as epileptogenic as the angiomatous malformation that has been removed—or, sometimes, more so. Epilepsy, *per se*, is not therefore a good indication for excision, unless it is quite disabling and uncontrollable by anticonvulsant drugs—a very unusual circumstance. Moreover, fits which were not present before operation may appear afterwards, and the patient may reasonably consider them to be a poor exchange for an uncertain protection against further haemorrhage. A familial tendency towards epilepsy in these cases should be considered an adverse factor.

Increased physical disability

It is important too that the possibility that the patient may be further disabled (apart from epilepsy) should be weighed most carefully against the estimated protection against further haemorrhage that the operation is likely to achieve. The



(*a*)



(*b*)

Fi [illegible]

patient's work, domestic and financial circumstances, and his adaptability to misfortune must all be evaluated. A left hemiparesis may be a relatively undisturbing and acceptable penalty to one individual, but disastrous to another. It is never justified to risk producing severe aphasia (one of the worst of all human disabilities), and the side of the dominant cerebral hemisphere must always be most carefully established beyond reasonable doubt by inquiring about handedness.

Indications for operation

The foregoing discussion is intended to convey an attitude of caution rather than conservatism towards the surgical treatment of cerebral angiomatous malformations, and to suggest that the indications for operation are largely relative.

Intracerebral clot

A strong indication exists, however, when there is, in relation to the malformation, an intracerebral clot that demands evacuation because it is a space-taking lesion (Fig. 12). At the same operation the causative lesion itself may be removed, if this is possible; for the liability to future epilepsy is, under these circumstances, not likely to be significantly increased by the operation, which is often facilitated by the haemorrhage having to some extent already dissected the malformation.

Small angiomatous malformations

Small angiomatous malformations, where they are easily accessible and, particularly, when they are in an area of relatively low epileptogenic potentiality, should be removed because they seem more liable to bleed than the larger ones.

Increased intracranial pressure

Occasionally, these blood vessel tangles interfere with the freedom of the cerebro-

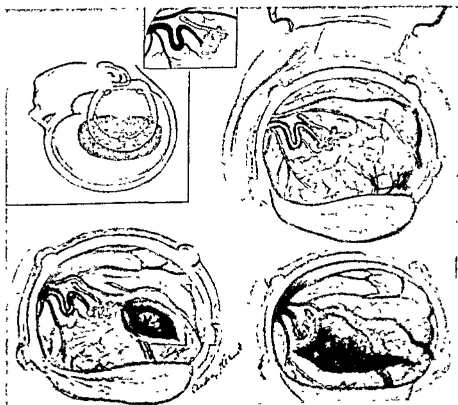


FIG 12—Excision of a small arteriovenous malformation and evacuation of the associated intracerebral clot. (The same case as in Fig 11.)

spinal fluid pathways and increased intracranial pressure results. An operation will then be needed, such as Torkildsen's ventriculocisternostomy, whereby an obstruction in the third or fourth ventricle, or in the aqueduct of Sylvius, may be by-passed.

Uncontrollable and disabling epilepsy

The last clear indication, already mentioned as an unusual one, is truly uncontrollable and disabling epilepsy—provided the lesion is not in the "speech area".

Radical excision

The technique will not be described, for it will be carried out *secundum artem*, with modifications according to the particular circumstances of the case. The stages of a typical operation are illustrated simply in Fig 13 Some form of artificial hypotension is commonly employed, plenty of blood should be available and, in the case of a large malformation, it may be wise to expose the internal carotid artery in the neck beforehand as a precaution against a severe haemorrhage in its territory. It is important that the arteries feeding the abnormality should first be clipped or tied, for this has the effect of shrinking the mass If veins are taken first, engorgement and

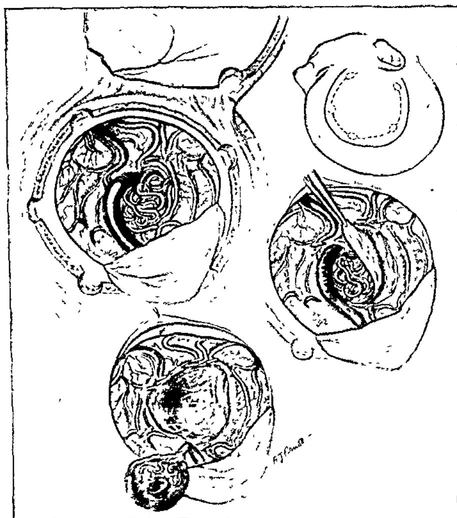


FIG 13 —Stages in the excision of a right posterior frontal arteriovenous malformation The arteriograms are shown in Fig 14

By courtesy of the Editor of the Annals of the Royal College of Surgeons of England)

rupture are likely to occur if the arterial blood, having been shunted, is unable to get away through the veins with its accustomed ease.

It is sometimes very difficult to tell arteries from veins owing to the highly "arterialized" blood that may be seen in the latter. Reference to the angiograms may help considerably, or the effect of temporary occlusion with plain dissecting forceps may be tried.

Radiotherapy and symptomatic treatment

Radiotherapy

This method of treatment, which was popular before radical excision was considered feasible, has now declined in favour for the understandable reasons that it seems only rarely to cure and because the complications of haemorrhage and epilepsy may follow despite its administration. McWhirter and Dott (1955) advise against it. Nevertheless, a recent, long-term, follow-up survey (Potter, 1955) has suggested that it may after all be of some value in protecting against lethal haemorrhage and in reducing subsequent disability. The evidence is not conclusive; but, provided that no harm is done, it seems right to offer any chance that there may be of a better prognosis, and radiotherapy is recommended, therefore, in cases for which radical excision is not considered suitable. It is known that the small cerebral vessels are affected by therapeutic x-ray dosage, and it is therefore not unreasonable to hope that these demonstrably abnormal shunting vessels should be more vulnerable. Such selective thrombosis of these vessels by accurate irradiation would be a theoretically ideal method of treatment, and a suitable technique may yet be evolved. The necessary accurate two-plane localization of the lesions has already been achieved by angiography.

Symptomatic treatment

The regular taking of phenobarbitone will usually control the epilepsy that may complicate these lesions, or keep it within tolerable limits. It may be necessary to add Epanutin, or to substitute one of the newer anticonvulsant drugs; and persistent attempts should be made to find a suitable medicinal regime for a patient whose fits are troublesome, before turning towards an operation that is likely to be dangerous or disabling.

Provided the headaches which may afflict the patient are not due to increased intracranial pressure, some kind of aspirin-phenacetin-codeine mixture or tablet will usually help, but for those that are migraine-like, ergotamine tartrate, either with caffeine (Cafergot) orally or alone by injection, may be required.

INTRACEREBRAL AND SUBDURAL HAEMATOMAS

Intracerebral clots

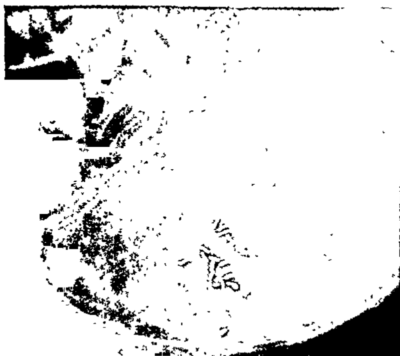
Where non-fatal haemorrhage results from hypertension, or from any cause, the natural process is for liquefaction of the clot to occur, followed slowly by absorption and ghosts, or the formation of a cavity which may communicate with the ventricle (porencephaly). This process may be hastened by surgical evacuation of the haematoma, but it is not certain whether the end result is thereby improved for the patient. [illegible] into its cavity, and may [illegible]

Burr-hole evacuation versus bone-flap craniotomy

Evacuation through a burr-hole may be achieved if the haematoma is liquid, but fluid may re-form. In hypertensive cases there is always an added risk that blind needling may cause further haemorrhage. On the whole, and since there is usually solid clot present, it is generally better to remove the haematoma by means of a formal craniotomy, when an incision is made into a suitable part of the cerebral



(a)



cortex, as in Fig. 12, and the clot removed under direct vision. It is remarkable how rapidly the adjacent brain brings together the walls of the cavity to obliterate it.

Subdural haematomas

Apart from those considered elsewhere (Botterell, 1948b) as complications of a known head injury, many subdural haematomas form in the absence of any clear history of trauma, although, one suspects, sometimes this may have been trivial and is forgotten. Occasionally, an aneurysm will rupture into the subdural space, and any other type of intracranial haemorrhage may extend in the same way.

Such haematomas are treated, as are the traumatic ones, by evacuation through two or more burr-holes; or, if they are solid, by turning a flap. At least one burr-hole should always be made on the opposite side, for subdural haematomas, particularly if trauma is the cause, are frequently bilateral.

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MAXILLA—CARCINOMA OF

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INTRODUCTION

Definition

The maxillary framework of the face is a complicated honeycomb of air spaces lined by mucous membrane and supported by bone. Carcinoma of the structures concerned is broadly referred to as cancer of the upper jaw. The tumours may be of many different types and invade from the oral surface of the bones or arise within the nasal sinuses. Occasionally carcinoma arises in contiguous structures and extends into the facial bones. Surgical removal almost always results in disfigurement and is, therefore, approached with reluctance. For these reasons diagnosis and treatment of such growths is often difficult and unsatisfactory. Present methods are better than in the past, but there is still scope for considerable improvement.

Primary growths

Carcinoma of the upper jaw may be divided into two main groups, primary and secondary The primary group includes those of the antrum, ethmoids, upper alveolus, palate and nasal fossae. Carcinoma of the sphenoidal air sinus is exceptionally rare.

Secondary growths

Secondary invasion of the upper jaw from contiguous structures is encountered when epitheliomas and rodent ulcers of the skin of the face and lip invade the underlying bone, and when growths of the mucous membrane of the cheek, or even tumours of the lower jaw, extend on to the upper alveolus.

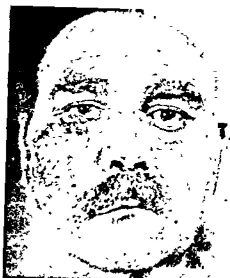
Responsibility for treatment

It can readily be understood that the problem is one of considerable complexity and that it is difficult to decide within whose province a particular case should fall. Since many of these epithelial tumours are radio-sensitive, it is natural that the radiotherapist should be very interested in the whole group, especially as he can treat some of them successfully and without disfigurement. The ear, nose and throat surgeon is mainly concerned from the diagnostic and operative side. But the general surgeon, the dental surgeon, the plastic surgeon and the dermatologist may all be concerned (with the maker of prostheses and the cosmetitian in the background). Each must know the capabilities and limitations of the others, otherwise the tumours are liable to get out of hand for want of advice from a new quarter.

Surgical ablation may be considered to be a crude method of treatment, but it must be realized that the growths themselves produce the worst deformity of all.

The deformity of untreated tumours

The features become distorted (Fig. 15*a* and *b*), pain is often intense; eating, drinking, breathing and even seeing may become difficult; accompanying infection and fistula formation is often associated with a terrible stench and the patient's state becomes one of pitiful disgust, witnessed usually only by his general practitioner—not by those who have failed to cure his tumour. Fear of radical surgery must not, therefore, be allowed to cloud the issue.



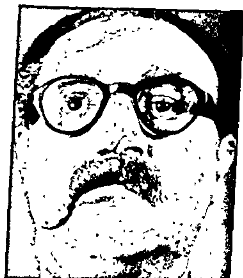
(a)



(b)



(c)



(d)

FIG 15.—Carcinoma of antrum, fungating through on to cheek (a) before radiotherapy; (b) persistent tumour with fistula formation, after radiotherapy, (c) after total excision of right upper jaw, (d) wearing external prosthesis

(*By courtesy of the Editor of Proc R Soc Med*)

INCIDENCE AND PATHOLOGY

Proportional incidence of primary tumours

Carcinoma of the upper jaw is not rare. The average number of patients with primary jaw tumours attending the Royal Marsden Hospital over the last 25 years has been 15 *per annum* Forty per cent have arisen in the antrum, 23 per cent in the nasal fossae, 17 per cent in the ethmoids and 10 per cent each on the upper alveolus and on the palate. The figures, which are approximate, have been supplied by Dr. Lederman and Dr. Dalley who will be analysing them in greater detail. Secondary tumours have been rarer.

Squamous-celled carcinoma

In the antrum, ethmoid and on the upper alveolus 80 per cent have been squamous-celled carcinoma Columnar-celled carcinoma and others, and those without histological diagnosis, make up the remaining 20 per cent. On the palate the proportion has been slightly lower, there being a greater number of salivary gland carcinomas. In the nasal fossae 75 per cent of epithelial tumours are proved squamous-celled growths and are four times as frequent as malignant melanomas, which present a special problem but which can be considered in the same treatment group.

SPREAD OF THE TUMOURS

Squamous-celled carcinomas spread by local invasion and remain amenable to local treatment for a considerable time. Lymph node metastasis is not common. In antral and ethmoid carcinomas detectable involvement of regional nodes was present in between 15 per cent and 18 per cent of all cases at their first examination. The proportion was rather lower in cases of carcinoma of the palate; somewhat higher, 25 per cent, in cases of carcinoma of the nasal fossae; and higher still, 50 per cent, in cases of carcinoma of the upper alveolus Generalized metastasis is rare

Invasion of the maxilla by rodent ulcer is often unexpectedly deep and more extensive than appears from the surface. Once the tumour has broken through a barrier such as the margin of an air sinus, it spreads rapidly in the deeper planes. Radiotherapy seems, on occasions, to drive a rodent ulcer underground.

SYMPTOMS AND SIGNS

Epithelial growths and ulcers of the skin, cheek, alveolus and palate are obvious by their presence, yet surprising mistakes are sometimes made in confusing oral types of carcinoma with fibrous epulides and with the distortion of soft tissues which occurs in association with chronic infection of the alveoli and palate. Leucoplakia should, of course, be kept under constant observation for any tendency towards neoplastic metaplasia.

The symptoms of the three other types of primary carcinoma of the upper jaw vary slightly (Wilson, 1954) In the case of the antrum the symptoms depend upon which part of the antrum is first involved Those arising on the inner aspect cause nasal symptoms. Those on the outer surface spread into the cheek and present as an external swelling, sometimes associated with considerable pain Upward extension of the tumour into the orbit will produce disturbances of vision, and downward growth, distortion of the palate or alveolus The patients, for example, may complain of nothing more serious than that their dental plate no longer fits properly. In the case of carcinoma of the ethmoid, nasal discharge with bleeding and obstruction are the commonest symptoms. Swelling, pain and eye symptoms occur later. Growths in the nasal fossa usually present with swelling in the nose or nasal obstruction with discharge which may be bloodstained These symptoms will usually be present before pain develops Frank epistaxis is the first complaint in only about 6 per cent of the patients Anosmia and external swelling occur but rarely.

All tumours may give rise to a feeling of fullness and discomfort at the back of the nose which is difficult to define but important to recognize.

DIAGNOSIS

The nature of ulcerating tumours presenting on the oral surface or in the nasal cavity can be discovered easily enough by taking a fragment for microscopical examination. Proper cutting punch biopsy forceps are best for this purpose and obtain the fragment without the need of local analgesia. The sample needs to extend well into the depth of the tumour in order to get a fair picture of its structure. Very often superficial



FIG 16 —Antero-posterior x-ray of maxilla to show an opacity of the left antrum due to carcinoma which is eroding upwards and medially into the nasal cavity and downwards and laterally into the substance of the cheek below the malar bone.

infection modifies the histological appearance and makes pathological interpretation difficult. If a negative or doubtful result is obtained, the test should be repeated Frequent biopsy of oral swellings will be rewarded by earlier diagnosis of malignancy.

Transillumination of the nasal sinuses is, of course, a simple and essential part of the routine clinical examination of these patients

Plain x-rays are of great value (Fig. 16), together with tomography, stereoscopic x-rays and other means of demonstrating the shape of air-filled cavities and the erosions of their margins These methods, however, may not be enough for the diagnosis of the deeper-seated tumours Needle biopsy occasionally helps, but usually operative exploration is necessary.

PROGNOSIS

Squamous-celled carcinoma of the antrum is generally taken as the yardstick for the assessment of prognosis of carcinoma of the upper jaw This is the only group in which sufficiently large numbers are at present available for analysis. The results of Lederman, Mill and Dalley (1956) at the Royal Marsden Hospital and Capps and Williams (1950) at St. Bartholomew's, both series covering many years, give between 34 per cent and 35 per cent 5-year recurrence-free survival rates. In other words, little more than one-third of these patients have, in the past, been cured of their disease. In the case of ethmoid tumours the results are somewhat worse and of tumours of the nasal fossa and palate, slightly better. Recently the results have been appreciably improved

TREATMENT

Maxillary antrum

Radiotherapy succeeded surgery as the most efficient method of treating these tumours at a time when surgery did not have the advantages of good general anaesthesia, blood transfusion or antibiotics There is no doubt that radiotherapy can give a result

which is well-nigh perfect in a tumour which is very radio-sensitive. Many, however, either do not respond at all or only partially.

Combined surgery and radiotherapy

Surgery is, therefore, combined with radiotherapy as a conjoint method of attack for the following reasons. Without exposing the tumour it is difficult to define the full extent of the growth. Without opening the antrum it is impossible to eradicate the sepsis and sequestra which very often follow irradiation therapy. For the partially radio-sensitive tumours it is necessary to eradicate what remains after such radiotherapy. The last and almost the most important reason is that the cavity from which the tumour is removed must continually be under observation in case a recurrence should develop.

The first planned treatment of antral tumours is, therefore, either surgery followed by radiotherapy or radiotherapy followed by surgery. At organized clinics this combined treatment has begun to yield a 50 per cent 5-year recurrence-free survival rate, the former method, surgery followed by radiotherapy, giving slightly better results than the latter. Radiotherapy alone has given about a 15 per cent 5-year recurrence-free survival rate, but one must remember that the cases included in this group are those who come with advanced disease in the first place and for whom the radiotherapy is given only as a palliative measure.

Radiotherapy methods

It is not within the scope of this article to compare the various methods of radiotherapy used. Suffice it to say that teleradium or telecobalt or super-voltage x-ray therapy are at present considered to be the best methods. The whole field is undergoing intensive development.

Surgical approach

The surgical approach to antral tumours varies little between the special clinics in London. The aim is to remove the bulk of the upper alveolus and hard palate on the side of the tumour. The floor of the nasal cavity is usually opened and the floor of the antrum altogether removed. The extent of the removal varies from case to case, but it must be enough to give a complete exposure of the tumour site. If this operation is done as the first step in the treatment, the tumour is coagulated with the diathermy current and removed there and then The antrum and those parts of the surrounding tissues which have been invaded by the tumour are then irradiated If this operation is done following radiotherapy, residual tumour is excavated in a similar manner.

Treatment of the cavity —At the end of the operation the cavity is dressed with a Stent mould which is replaced by a plastic obturator as soon as the cavity has healed. Sepsis and sequestrum formation often delay healing The formation of sequestra can be minimized, at the time of the operation, by developing a precise technique in the use of the coagulating diathermy and by filletting out the thin bones of the maxilla with fine nibbling forceps, leaving flanges of mucous membrane and periosteum to protect the bone margins

Treatment of lymphatic metastases

The question of treatment of lymphatic metastases must be considered at the same time as the treatment of the primary tumour. When no involvement is detected, the nodes should not receive treatment either by radiotherapy or by surgery. If they are involved, it is well to treat them by radiotherapy in the first place. The reason for delaying block dissection at this site (in contrast with the policy adopted towards growths of the tongue) is that they appear to be more radio-sensitive. Further, it is generally supposed that the nodes first involved are those high on the pharyngeal wall which are not accessible to excision by surgery. Should the lymphatic metastases



(a)





(c)



(d)

Fi . [illegible]

not prove amenable to radiotherapy or recur later, block dissection should be done forthwith.

Follow-up and treatment of recurrences

The cavity from which the antral tumour has been excavated and destroyed is observed carefully at intervals of one month for the first year and after that less frequently Recurrences must be detected immediately. Here again the punch biopsy forceps are of great value in proving microscopically the presence or absence of growth. When present it must be treated without delay by further diathermy removal or by intracavitary irradiation.

Radical treatment of recurrence.—If these methods fail and the tumour is found to be extending in any direction other than posteriorly, radical excision of the upper jaw should be done by the classical method from without, and by cutting around

the tumour. The cheek is turned back by an incision cutting through the upper lip in the midline and extended up in the lateral nasal fold It is then carried laterally just below the orbit (Fergusson's operation), or modified in some other way to meet the circumstances of the particular case (Cade and Lee, 1949). For example, if the skin of the cheek is involved, that part has to be removed together with the tumour, leaving an external defect (Figs 15*c*, 17*a* and 18*a*) If the floor of the orbit is involved, that has to be removed, perhaps together with the eye (Figs 15 and 17). If the growth has extended medially, it is often necessary to remove part of the nasal septum or



(*a*)



(*b*)



(*c*)



(*d*)

[illegible]

defect

even the nose itself. Inferior extension may cause one to excise more of the soft palate and possibly the lip. The operation itself is crude and bloody and old-fashioned, but not to be scorned on that account.

As much as possible is done to repair the external defect at the time of the operation, but excision of the tumour must not be skimped for fear of enlarging an already gross deformity.

Later lymph-node dissection.—It is unwise to combine such an operation on the upper jaw with any major block dissection of the neck, which is done later if necessary. It usually consists of the full unilateral dissection of Crile, removing the sternomastoid and the internal jugular vein together with all possibly involved lymphatic structures.

Ethmoid tumours

The approach to these tumours is somewhat similar to the approach to antral growths. Once the diagnosis has been established, sometimes by an operation involving an incision around the medial edge of the orbit on the side of the growth, the tumour site is fully irradiated with super-voltage beam therapy. This has been found to be better than teleradium, telecobalt or radium implantation because the dose can be better calculated and more accurately applied. The higher the voltage, the less the treatment is disturbed by differential bone absorption. Everything is done to protect the eye on the opposite side but very often the homolateral eye has to be sacrificed, either to enable the tumour to be more efficiently exposed or as a result of cataract following radiotherapy.

Tumours of the nasal fossae, palate and alveolus

Radiation therapy

It has already [illegible] palate and alveolus are easy to diag[illegible] in the form of te[illegible]



FIG 19—Infiltrating squamous-cell carcinoma of upper alveolus and palate, internal prosthesis in position, seven years after double upper jaw excision through extensive Caldwell-Luc incision (Right external carotid artery ligated, left temporarily occluded)

(By courtesy of the Editor of Proc. R. Soc. Med.)

Surgery

Should radiation therapy fail, as it sometimes does, operation should follow. The type and extent of the operation must be thoroughly and carefully planned for each patient. It is impossible to lay down hard and fast rules for the surgical treatment of these growths, but the first principle of treatment is that the exposure must be adequate. This often means that the cheek has to be divided and turned back to one side or the other. Sometimes, if the tumour has not extended beyond the confines of alveolus or palate, it may be possible by ingenious design to do a radical extirpation without producing an external scar (Fig. 19). The deformity can almost always be made good by an effective and comfortable internal prosthesis.

Invasion of the maxilla by secondary carcinoma

Carcinoma of the mucous membrane of the cheek must be treated by radical surgery. Fig. 20 illustrates a patient in whom such a growth had extended not only on to the left upper alveolus but also on to the left mandible, necessitating partial excision of both these bones together with removal of the whole lining of the cheek itself. The lymph glands were involved and a block dissection was done at the time of the original operation. The illustrations show that the external deformity is not very severe. The patient has never had a prosthesis and leads a perfectly normal life, eating virtually normal food. It is in such cases that the general surgeon must not be omitted as a member of the team. Fig. 21 shows another patient in whom the upper jaw was resected for an adamantinoma. This had extended up from the right lower jaw which had been removed in the past.

Rodent ulcers of the skin invading upper jaw

These cases are usually referred to the general surgeon after radiotherapy has been tried and failed. An external defect must be accepted, the extent of tissue removal being governed by the extent of tissue invasion Microscopical examination by frozen section is of great value in ensuring eradication of the deeper extensions of the tumour. It must be emphasized again that the terebrant type of rodent ulcer very often penetrates far deeper and more extensively than can be judged by examination from the surface. On one occasion the removal of what appeared to be no more than a radionecrotic ulcer of the bridge of the nose led the author into a deep excavation which ended only with the evacuation of rodent ulcer from the sphenoidal air sinus (Fig 23). It is worth remembering, too, that although radiotherapy may have failed as a first line of treatment, it may be possible to return to it after the tumour has been excavated and fresh tissues have been exposed.

SPECIAL TECHNICAL CONSIDERATIONS

Control of haemorrhage

Operations on the upper jaw are often of considerable extent. Loss of blood should be made good by transfusion, but the loss should be minimized. Hypotensive anaesthesia and diathermy coagulation are of great value in this respect. Ligation of the external carotid artery also undoubtedly helps. In the case illustrated in Fig. 19, the external carotid artery was tied on one side and temporarily occluded on the other as a first step in the operation. Momentary release of the temporary occlusion proved the value of the method

Split-thickness grafting of internal mucosal defects

Surprisingly few operations on the upper jaw require skin grafting of mucosal defects. In some cases, however, especially of tumours of the alveolus extending out on to the cheek, or of the cheek on to the alveolus, large raw areas are inevitable.





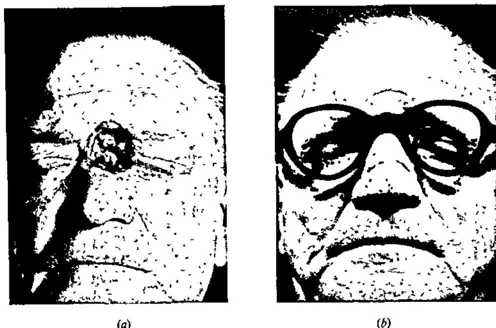
Fig. 20.—Squamous-cell carcinoma, recurring after radium therapy, of the left cheek and invading both jaws; the condition eighteen months after excision of left upper and lower jaws with Crile's block dissection of neck is shown

(By courtesy of the Editor of Proc. R. Soc. Med.)





Fig. 21.—Patient in whom right upper alveolus, hard palate and right mandible have been resected for adamantinoma.



(a) (b)

FIG 22 —Recurrent rodent ulcer of bridge of nose, extending back into the sphenoidal air sinus (a) After healing, (b) with external prosthesis in position

If they are allowed to granulate and contract, there will be gross distortion of the face by scarring from within and the healing time will be prolonged. It is better, therefore, that these surfaces should be grafted at the time of the original operation. Haemostasis is secured. A Stent mould is constructed to fit the cavity. This mould is then covered with a split-thickness graft so that the viable surface comes into contact with the denuded area of the cheek. With careful fixation this graft will take within 5 or 6 days The graft should be generous in size. Feeding by Ryle's tube will be necessary while the mould is in place

The internal palatal and alveolar defect

The construction of prostheses for the filling of internal defects has now reached such a degree of skill that the surgeon has come to accept of the dental surgeon a good functional result, however much of the masticating apparatus of the upper jaw has been removed (Figs. 17 and 20). The cavity into which the prosthesis fits must be prepared with care and be free from sepsis All sharp ridges of bone should be filleted out. The dental surgeon should examine the patient before operation and will then know the type of apparatus required of him. He may even be able to make a plastic mould for the temporary dressing of the wound. Patience, however, is required in the fitting of the permanent plates and in the training of the patients in how to use them properly and to the best advantage.

The external defect

It is the external defect and the possible loss of an eye which scares patients and doctors off major operations for excision of the upper jaw It must, however, be emphasized again that the worst defect of all is the defect of an incurable tumour fungating on to the surface and causing intense distress.

It is now possible to fit external prostheses which will enable patients to face life again with reasonable equanimity. Such appliances, however beautifully and skilfully constructed (Figs. 17*b* and 22*b*), are regrettably never entirely satisfactory. They need

constant attention at inconvenient times and they tend to leak saliva, beer, and the like. The patients find they cannot enjoy a smoke, partly because they are unwilling to risk the appearance of tobacco smoke from odd parts of their face, thereby drawing attention to themselves in a rather dramatic manner. They cannot sneeze or blow their noses without risking the precipitate dislodgement of their spectacles and part of their faces. If the apparatus incorporates an eye, the constant stare is not pleasant. From the employment point of view also, the patients find an external prosthesis a great embarrassment and employers are unwilling to accept them on account of the slightly macabre curiosity that such conditions arouse in other workers, even though the device may be well-nigh perfect (Fig. 17*b*). However, if the fistula is closed with a roof of skin (and the empty eye-socket covered with an eye-shade), the patient will be accepted without comment (Figs. 17*d* and 18*d*).

The closure of external defects should, therefore, be the ultimate object in most operations for extensive jaw resections. Many matters need to be borne in mind in planning such closures. Firstly, the tissues have usually been heavily irradiated and allowance must be made for this in the extirpation of the disease and the time allowed for healing. Secondly, growths may recur, so that only those with an associated palatal defect through which the cavity can be examined should be closed until it is reasonably certain that the growth is cured; in such circumstances 3 to 5 years must elapse. Thirdly, the patients are usually not young; they have often endured months of radiotherapy and had previous operations; they are unwilling to spend more months going through a series of plastic operations. It is advisable, therefore, to do such closures by the most expeditious method, even at the expense of visible scars on the forehead.

Lined forehead pedicle flap

The lined forehead pedicle flap has provided a solution for many of these patients. This method is singled out for emphasis, not because it is necessarily ideal but because it is usually a practicable and acceptable compromise between being left with a prosthesis and the prolonged disability and fixation necessary when skin flaps are raised from the body. The operation is done in only three stages and without immobilization.

Stage one.—A pattern of tantalum foil is cut to fit the defect. It is placed on the forehead to give the size and position of the pedicle flap required, which is marked [illegible]

pattern. It is folded on itself over the tantalum foil, viable side out, and [illegible] under the end of the scalp flap. The whole pedicle, together with skin graft and tantalum, is then stitched back into place on the scalp and bandaged firmly into position (Fig. 18*c*).

Stage two.—A fortnight later the pedicle is raised again and the two halves of the split-thickness graft are separated from each other. The pedicle is brought down and its stem is tubed upon itself. The deeper grafted surface of the distal end is incised in a shallow groove around its edge to give it a double cuff. A similar incision is carried around the margins of the defect and the edges undermined, the outer edge to be stitched to the skin of the scalp flap and the inner to be stitched to the split-thickness skin graft on the under surface of the flap (Figs. 17*c* and 18*c*). All the relatively inaccessible sutures are placed before being tied so that the graft can be drawn gently and firmly into its precise position. The denuded area of scalp is dressed with tulle gras.

Stage three.—Three weeks later the pedicle is divided, the distal part is trimmed and settled into the skin of the cheek and the proximal part is returned to the bare area of the forehead. Within a week of this third stage of the operation all wounds are usually healed. The total time taken in filling in the defect of the cheek is thus 6 weeks.

When the tumour has extended far out on to the cheek and the malar bone has had to be removed together with the orbit, such a flap may be placed in position by rotating rather than by tubing the pedicle (Fig 23) In such a case the closure of the defect will be completed at the second stage of the operation, when the bare area of the scalp is covered with a second split-thickness graft. The total time for the closure of the facial defect may then be no more than 3 to 4 weeks.

JOINT CONSULTATION CLINICS

It will be appreciated that the treatment of carcinoma of the upper jaw has been most unsatisfactory in the past. With the development of special centres it is becoming



FIG 23 —Photograph taken on the 21st day after commencing closure of orbital and antral defect by lined forehead pedicle flap, following excision of extensive terebrant rodent ulcer

much better, partly as a result of improvements in radiotherapeutic, surgical and anaesthetic techniques, but largely because the various members of the teams responsible for the treatment of such tumours are co-operating more closely and

team are undoubtedly the ear, nose and throat surgeon and the radiotherapist, but they must be backed up by other members who are immediately available, such as the interested general surgeon, the plastic surgeon and the dental surgeon Every member must aim to recognize the moment that he has done all he can for a particular patient, so that there is no delay in someone else taking over. The term "Joint Clinic" must mean that the different specialists work in close, continuous and immediate co-operation

SUMMARY

The first planned treatment of primary carcinoma of the upper jaw, by limited surgery and radiotherapy, is designed to cure with the minimum of defect. If this succeeds, the site of the growth must be kept under careful scrutiny for recurrence. If it fails

or if a recurrence develops later, more radical and traditional methods of surgery must fearlessly and unhesitatingly be adopted. The defect, whether internal or external, should be dealt with later. Secondary invasion of the upper jaw by carcinoma should usually be treated by radical surgery.

ACKNOWLEDGEMENT

I am indebted to Dr. M. Lederman and Dr. V. M. Dalley for their help in allowing me to study the figures they will soon be publishing; to Miss J. Hunt of the Royal Marsden Hospital and Mr. N. K. Harrison of St. Bartholomew's Hospital for the photographs; and to Dr. R. A. Kemp Harper for Fig 16. Figs. 15, 17, 20 and 21 are reproduced by kind permission of the Editor of the *Proceedings of the Royal Society of Medicine*.

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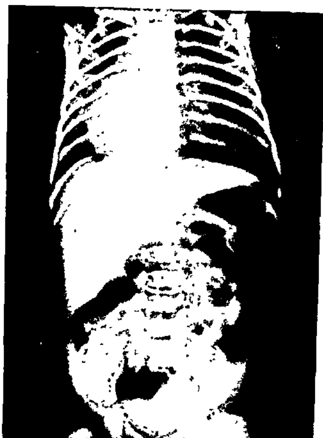


FIG. 24.—Progressive and fatal atelectasis due to bronchial irritation by gastric reflux. (Right lower lobe collapsed.)

On two occasions a fine cord has been seen joining the two segments, in one of these a small cyst was incorporated In no case did a fistula involve the upper segment and this must be considered a very rare event.

Association of oesophageal atresia with other congenital defects is said to be infrequent but the Leeds series has revealed a formidable list under the following headings:

Cardio-vascular.—Seven auricular septal defects (post-mortem findings), two auricular and ventricular septal defects (one with pulmonary stenosis), and one instance each of right aortic arch, anomalous innominate artery, anomalous right subclavian artery, and harsh systolic murmur.

Gastro-intestinal.—Three recto-vaginal fistulas, two gastro-duodenal dilatations without organic obstruction, an imperforate anus, and an ileal atresia.

Genito-urinary.—Single cases of solitary kidney, cystic ectopic kidney, and bilateral megalo-ureter.

Miscellaneous.—Two accessory auricles (one with branchial sinus), one hemi-vertebra and extra rib, and one club foot.

PHYSIOLOGY

The first hazard of oesophageal atresia is asphyxia at birth. Liquor amnii in the mouth seems excessive and is not readily cleared. Repeated inhalation of this causes cyanosis and a bubbling cry. This initial trouble gradually recedes, but is replaced by recurrent rattling in the pharynx, dribbling of saliva, and violent fits of coughing which may lead to retching and ejection of blobs of mucus from the blind oesophageal pouch. A tranquil period follows until once more the process is repeated. Under these circumstances attempted feeding is very ill-advised and results in immediate choking, cyanosis and rejection of the feed usually through the nose. Inhalation of liquor

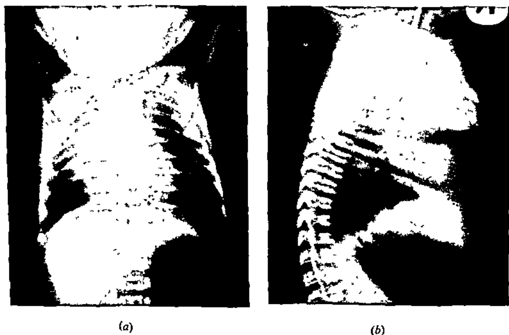
amnii or clean saliva is of little consequence once it is cleared, but milk in the bronchial tree sets up a pneumonitis which may prove fatal.

Crying forces air from the bronchial tree through the fistula into the stomach which becomes so distended that its outline is visible through the abdominal wall. This distension often proves a serious embarrassment to respiration which is so largely diaphragmatic at this age. Distension also promotes excessive gastric secretion, and when air is returned by belching digestive juice accompanies it and severely irritates the bronchial tree, also making oral secretions acid to litmus. Excessive bronchial secretion inevitably appears leading to progressive respiratory difficulty and atelectasis (Fig 24) The time interval for this is variable and appears to be related to the extent and activity of gastric reflux, which, on occasions, has resulted in severe digestive ulceration of tracheal and bronchial epithelium.

Some early cases may be in worse condition than others reaching surgical aid when several days old This paradox is usually related to extreme gastric dilatation which may call for urgent relief as a preliminary measure In this respect a quiet weakly infant 3–4 days old often proves to be in better condition than a lusty one with a powerful cry, through which attention is drawn to the atresia at an earlier date by damaging the lungs with reflux.

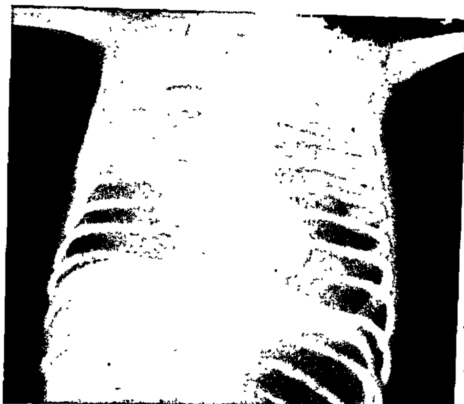
On the rare occasions when no fistula is present the lungs remain in good condition for a long time; no gas reaches the abdomen to stimulate and distend the stomach and there is no gastric reflux to damage the bronchial mucosa or precipitate consolidation. In fact the blind termination of the upper pouch is much less of a danger to immediate survival than the tracheo-oesophageal fistula.

Dehydration with rapid weight loss makes these children wizzened and emaciated in a few days. As this progresses the bronchial secretion becomes increasingly tenacious and difficult to raise. Body temperature often falls easily to a low level particularly in the premature infant and is followed by irreversible cardio-respiratory depression.



(a) (b)

FIG 25 —(a) and (b) Radiological confirmation of diagnosis with catheter and *Lipiodol* Note: (1) gastric distension requiring preliminary gastrostomy; and (2) incomplete expansion of right upper lobe which soon cleared



(*a*)



(*b*)

Fig. 26.—(*a*) Lipiodol inhaled into right lung, (*b*) consolidation of this area 24 hours later.

DIAGNOSIS

Familiarity with the clinical behaviour of these infants should immediately arouse enough suspicion to prevent all attempts at feeding until the oesophagus has been explored with a sterile urethral catheter. This should not be so slender that it can curl up in the pharynx to simulate a free passage into the stomach and it should be rigid enough for the fingers to recognize the point of obstruction at a measurable distance (usually 4–5 inches from the lips) This same catheter may be used to empty the accumulated mucus from the pouch by gentle suction with a syringe. Under adequate conditions in hospital, Lipiodol (but never barium) may be used for radiological confirmation (Fig. 25*a* and *b*). A very small amount is injected by catheter into the pouch since any excess over 0 5 millilitre is liable to be inhaled into the lungs where it frequently causes sufficient reaction to promote segmental atelectasis (Fig. 26*a* and *b*). For this reason it is bad policy to give Lipiodol by spoon for the examination, and all traces of Lipiodol should be aspirated as soon as radiographs have been obtained. One of those should include the abdomen to show up gas and the degree of gastric dilatation present (Fig 25) Full lung expansion will be confirmed on the same film; a collapsed upper lobe does not necessarily mean reflux bronchial damage since this is the last part of the lung to expand after birth, but atelectasis elsewhere carries a poor prognosis One final point should be sought, the presence of a right aortic arch which would change the side of exploration from right to left (Fig. 27).

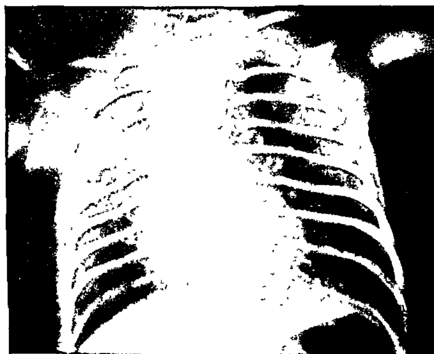


Fig 27 —Right aortic arch requiring left-side exploration

PRE-OPERATIVE MANAGEMENT

Prior to admission

The stage is often set for success or failure of surgery at this level. Vital early diagnosis would appear to cause no special problems with only a catheter required; but because the condition is seldom encountered in home midwifery delay not uncommonly involves several days of lung damage by reflux, to which milk pneumonitis may be

added. Dehydration, temperature depression, and secretion inspissation are progressive with this delay and *the earliest possible use of incubators* especially for transportation does much to improve respiratory distress. It has been common practice to posture the child head down to aid elimination of saliva but this encourages deadly gastric reflux. Oral secretions should be dealt with by gentle suction using a catheter in the pharynx whilst the child is propped up to keep gastric secretions away from the cardia. Penicillin helps to combat infection, and all who handle the child should wear masks and gowns and use scrupulous care in hand washing.

Resuscitation measures

Improved results have followed full appreciation that these infants are seldom ready for surgery on admission. Instead of being rushed to theatre, most cases now *spend up to 12 hours being prepared in an incubator.*

Under this plastic dome the child can be nursed naked with easy access and full observation free from chilling exposure and restriction of respiratory effort by clothing. The floor of the incubator is tilted feet down and the pharynx is cleared of saliva by suction as required. In a few hours laboured breathing often becomes tranquil. Meanwhile, dehydration is adjusted with subcutaneous glucose 2½ per cent combined with hyaluronidase, saline being avoided. Vitamin K and penicillin are given prophylactically.

If breathing fails to improve in the incubator due solely to the great degree of stomach distension a preliminary gastrostomy under local anaesthesia will usually bring marked improvement.

Clinical and radiological assessment of the situation can be completed without removing the child from the incubator and when the time for operation is near an intravenous drip is started using fine Polythene tubing into the saphenous vein at the ankle. If this tubing is left long, simple strapping will keep it in place in spite of *vigorous kicking because it is so light. With careful aseptic technique this drip* will last several days using half strength reconstituted plasma in 2·5 per cent glucose at the rate of 300 millilitres per day. Blood loss at operation is replaced by injecting blood slowly into the drip in fractional doses 10–20 millilitres at a time. Average requirements seldom exceed 50–60 millilitres.

RECONSTRUCTIVE TECHNIQUE

Anaesthesia

Premedication for operation should be 1/400 grain atropine without a narcotic.

Induction with ether and oxygen short of full anaesthesia desensitizes the larynx *for intubation* and prevents bronchospasm. Excess bronchial secretion is then removed and controlled respiration with adequate relaxation is obtained on ether and 10–15 per cent cyclopropane in oxygen. Curare seems unnecessary and undesirable but when more relaxation is required for a difficult stage of the operation an ultra- [illegible] 1 milligram per [illegible] tomach becomes [illegible] en done and the tube remains open.

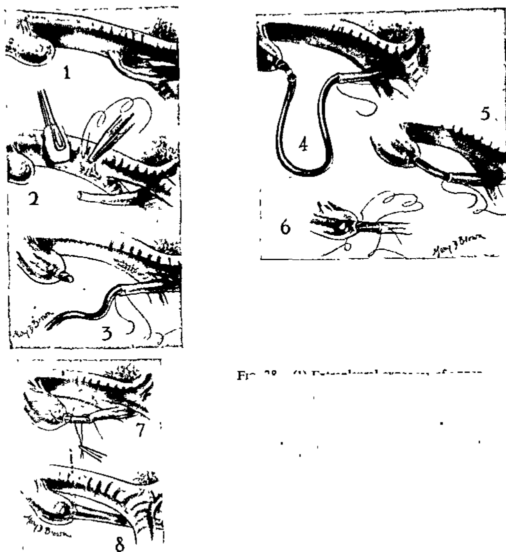
Operation

As already mentioned, where gastric distension is present a gastrostomy is made before the chest is opened.

Provided the aortic arch lies on *the left, the right fourth rib is removed* and an extra-pleural strip carried out to expose the posterior mediastinum from the pleural apex to the lung root (Fig. 28 (1)–(8)). Apart from later advantages this strip, which is

not difficult, helps in control of the lung by retractors. The vena azygos is divided

the trachea with fine catgut, the tip of the lower segment may need trimming back a few millimetres if its blood supply is in doubt.



Anastomosis

An end-to-end reconstruction is completed after splinting both segments with a catheter, which is first passed into the stomach through the lower segment. As mucosal retraction easily occurs the first interrupted stitch is placed in the lower segment before the catheter is introduced After the blind pouch has been opened the proximal end of this catheter entering the stomach is withdrawn into the mouth by stitching it to a catheter previously introduced by mouth. Interrupted stitches are placed in a

tied, leaving knots entirely on the outer surface; a good watertight joint is then

produced, in spite of a certain amount of tension. The splint catheter is then withdrawn.

Drainage

As the chest is closed a small underwater drainage tube is left in the extra-pleural space together with antibiotic powders. If not already done a gastrostomy is best provided in all cases. The finest chromic catgut seems the most desirable suture material for such a delicate oesophageal anastomosis, but sometimes variable tension requirements may call for something stronger. Thicker catgut is too bulky for a neat result free from stenosis and the best alternative is a very fine steel wire or nylon both of which can be obtained in a pliable plaited form easy to handle. Silk causes too much tissue reaction and spread of infection by capillary attraction.

A wide gap may be impossible to bridge by direct anastomosis and this is usually the case when the lower segment is in part atretic and no gas is seen in the abdominal radiograph (Fig. 29). With this situation two lines of thought have developed. The



Fig. 29.—Abdomen free from gas in atresia without fistula.

first is a strategic retreat with cervical oesophagostomy and gastrostomy. Survival from this produces a pitiable child who at best cannot learn to eat until months later, when multi-staged plastic operations have produced an antethoracic oesophagus, after much distress to all concerned. The alternative plan is an all-out attempt at bridging the gap using a free Thiersch graft as a skin-lined tube sutured to each segment. Such an attempt on one case in Leeds very nearly succeeded when a small leak caused death from an empyema. When examined at autopsy three weeks after operation 90 per cent of the graft had taken.

POST-OPERATIVE CARE

To avoid interference with chest movement wound dressing should be very light and strapping reduced to a minimum, but the three essential tubes, chest drainage, gastrostomy and intravenous drip should be secure.

Immediately after bronchial toilet and removal of the intratracheal tube, no time should be lost in returning the child to an incubator ready waiting for it in the theatre. This is a priceless asset in dealing with the nursing problems of this stage. Breathing is unhampered by clothing in an atmosphere free from droplet infection yet moist and



FIG. 30.—Gastrostomy feeding technique in an incubator

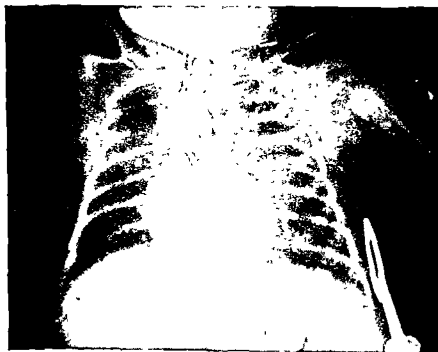
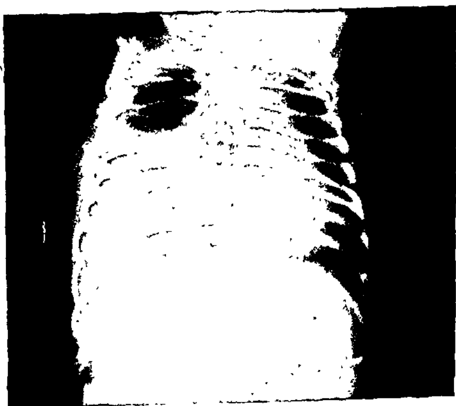


FIG. 31 —Anastomotic stricture



(*a*)



(*b*)



(c)

FIG 32.—(a) Localized extra-pleural leakage healing spontaneously on gastrostomy feeding; (b) large leakage, with extra-pleural pneumothorax, requiring closed intercostal drainage; (c) fistula tube track when nearly healed by intercostal drainage

maintained at 90°F. with additional oxygen in known concentration if required Regular changes in posture are made from side to side, yet handling is reduced to a minimum without loss of efficiency. Many of these babies are premature and require special attention on this account. In particular, temperature regulation defects are critical after surgery. The need for chest drainage ceases after a few hours and unless the tube is removed it may provoke unnecessary fluid accumulation, lung damage or restriction of chest movement.

Circulation and fluid balance

Blood is seldom needed after replacement of the loss during operation, but fluid balance requires intravenous therapy for 2–3 days at least before gastrostomy feeds may be started. Half-strength reconstituted plasma in 2·5 per cent glucose provides protein, carbohydrate and water in physiological amounts, but the daily intake should not exceed 300 millilitres. Saline should be avoided since the neonatal kidney is extremely conservative with salt and oedema may result.

Respiration

Routine turning from side to side encourages regular expansion of both lungs and clearance of bronchial secretion particularly in conjunction with head-down tilting of the mattress which can be permitted now the fistula is closed. Tenacious secretion may be loosened by detergent mist from an atomizer. If breathing becomes laboured or ruttling in character retained secretion should be suspected even when the lungs

show radiological translucency. It is easier to clear the trachea at this stage than to wait for atelectasis to develop. A small laryngoscope and a fine bronchial sucker used with full aseptic precautions and minimal trauma by a skilled endoscopist gives better results than a suckling bronchoscope

Caution should be used with oxygen therapy since exposure to concentrations above 60 per cent for any length of time carries serious risk of lens damage in the newborn.

Feeding

A cautious start is made with gastrostomy feeds at about the third day using 2 drachms of weak glucose hourly and watching gastric residue before each feed. Without this care a large vomit easily proves fatal from inhalation asphyxia at this stage. By gradual progress to half-strength milk, feeds are built up, watching for diarrhoea from fat intolerance—a not uncommon occurrence.

All feeds should be given very slowly using a small head of pressure by gravity only (Fig. 30). Milk should be cleared from the gastrostomy tube with a little glucose otherwise rennin from the gastric juice will block it with junket. Unexplained vomiting or diarrhoea may be due to the gastrostomy tube which is liable to be left a little further in the stomach each time the dressing is done. Unless the position is corrected regularly it either coils up and irritates the stomach or passes into the small bowel causing diarrhoea.

It is probably inadvisable to permit glucose feeds by mouth before the seventh day, by which time leakage is less likely to appear and oedema should have cleared leaving a reasonable lumen. The appearance of dysphagia at this stage is usually due to local infection which should be left strictly alone to settle down without dilatation or further feeds by mouth. A true anastomotic strict [illegible] week and if oesophagoscopy reveals no infla [illegible] dilated again at regular intervals by [illegible] anaesthesia.

Early feeds are seldom completed by mouth and the residue is given by gastrostomy tube which is retained if necessary for several weeks until suckling is strong and weight is increasing steadily.

POST-OPERATIVE COMPLICATIONS

Stenosis

Slow feeding and a crowing cough are the warning signs of obstruction but unless these are severe it is easy to withhold dilatation too long, with serious consequences from chronic lung infection (Figs. 31 and 34). Stenosis seldom responds to a single dilatation and those concerned with managing the child after it leaves hospital should be aware of this since the need for further attention varies in an unpredictable way for several months, although the ultimate prognosis is good.

Anastomotic leakage

If early in appearance this is usually a technical fault often based on unavoidable tension at the suture line. Local sepsis may cause leakage a few days later, and during this period it is distinctly unwise to attempt dilatation of an inflamed anastomosis.

With crying or respiratory distress the diaphragm pulls hard on the lower segment repeatedly and few other viscera would heal an anastomosis under such tension, yet in this series only 7 leaks occurred with 35 operations. After transpleural reconstruction a pyo-pneumothorax from leakage was invariably fatal, but with an extrapleural approach the infected space was limited and even when large enough to warrant closed intercostal drainage it usually healed remarkably well whilst feeding continued by gastrostomy (Fig. 32).





(*a*) (*b*)

FIG 33 —(*a*) Recurrent tracheo-oesophageal fistula; (*b*) after surgical repair

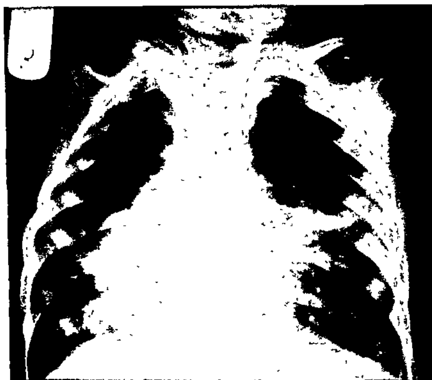


FIG 34 —Bilateral bronchiectasis caused by stenosis and inhalation of feeds.

Recurrent tracheal fistula

This occurred twice and one of these was successfully repaired when it failed to heal after conservative management for a month (Fig. 33).

Dysphagia without stenosis

Some of the survivors have a crowing cough, frequent attacks of sneezing and derangement of the pharyngeal swallowing mechanism. The noise they produce is characteristic but the cause remains unexplained. Some neuro-muscular incoordination seems to be present and may be inherent with atresia, but vagal damage at the operation site cannot be excluded.

High intestinal ileus

Twice some apparent intestinal obstruction has been met. Lipiodol would not pass the pylorus in one and the duodeno-jejunal flexure in the other yet in both meconium had been passed. When explored no organic obstruction was found, and this neuro-muscular disorder, probably related to the vagus nerves, has led to greater respect in handling them during the reconstruction.

Bronchiectasis

This is a consequence of untreated anastomotic stenosis which causes chronic lung infection by repeated inhalation of feeds, and has virtually disappeared as a complication since the association was appreciated and the necessary dilatations were provided (Fig. 34).

OESOPHAGUS—THE SURGICAL ANATOMY OF COMPETENCE AT THE CARDIA AND ITS RESTORATION IN HIATUS HERNIA

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Importance of the correctly-functioning cardia

The cardia is so designed that it permits unobstructed passage of nourishment or air into the stomach yet resolutely prevents return of either except by the organized processes of belching or vomiting; and this restraint is accomplished regardless of extreme physical exertion or postural change The cardia mechanism is so smooth that it is easily belittled by inadequate description, and even more easily taken for granted when mutilated by carefree surgery. To the well-being of the individual it may rank in importance just as high as continence at the anal sphincter, and no ingenuity is too great when aimed at restoring this function when deranged by herniation at the diaphragmatic hiatus As the components of the cardia mechanism are examined in detail, together with the possible consequences of too much active gastric juice in the oesophagus (Aylwin 1953), it is clear why displacement of the cardia is the main cause of incompetence and how best this is controlled by restoring normal anatomy as stressed by Allison (1951)

THE MECHANISM OF COMPETENCE

For descriptive purposes the composite anatomy relative to the function of the cardia is best broken down into three parts· (1) the contractile diaphragm round the oesophagus; (2) the oblique gastric muscle and mucosa near the cardia; and (3) the fascial link combining these structures

To avoid misleading terms like sphincter and valve a proper name for the whole appears to be "the cardia mechanism."

The hiatal muscle

This muscle is thick and fleshy round the oesophagus and takes the form of a sling, the limbs of which have unilateral innervation respectively from the right and left phrenic nerves, and its extremities are attached to the left leaf of the diaphragmatic central tendon and the first three lumbar vertebrae as part of the right crus When contracting, this sling draws the cardia more to the right than downwards (Fig. 35) and grips it tightly; a combined movement which is appreciated clearly during oesophagoscopy, or by palpation when the abdomen is open under local anaesthesia A similar angulating constriction is applied to the intestinal tract at the pelvic diaphragm by the pubo-rectalis section of levator ani; and in like manner at the hiatus, force meets force when intra-abdominal pressure is raised by straining Furthermore, neither of these sling muscles may be cut, scarred or paralyzed without serious risk of lost control. There are minor bands of muscle crossing behind the

oesophagus from one muscle limb to the other in most individuals. These slivers carry the nerve supply of their sides of origin, and fortify the hiatus against divarication.

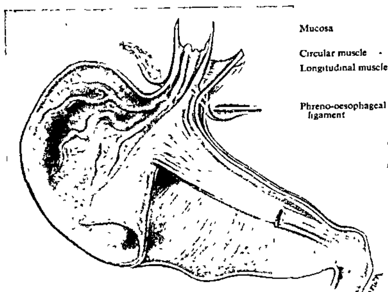
The ligaments of the cardia

These ligaments support the lower end of the oesophagus like the guy ropes support a marquee against forceful up-drafts. This fascia from both surfaces of the diaphragm unites at the margins of the hiatus to bridge the narrow gap and reach the oesophagus. There it unites with the loose but strong fascia propria at a level several millimetres higher than the mucosal junction of oesophagus and stomach (Fig. 36). This union sends many fibres which penetrate the muscle layers of the oesophagus to gain a firm attachment to the mucosa across the mobile submucous plane at the same level. At other levels there is nothing comparable with this circle of fixation, which may be

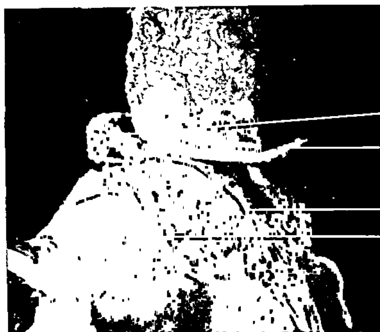


FIG. 35.—The diaphragmatic hiatus from below, showing the arrangement and action of the hiatal sling

demonstrated at oesophagoscopy by *testing for mucosal mobility* with a swab. It may be seen during Heller's operation for cardiospasm, when it is easily responsible for an inadvertent nick in the mucosa. Furthermore, it can be shown in fresh post-mortem specimens by injecting fluid under the mucosa of stomach or oesophagus which elevates the mucosa easily except *along this line just a few millimetres above* the cardia (Fig. 37). This phreno-oesophageal ligament carries small branches of the



(*a*)



(*b*)

FIG 36—(*a*) The phreno-oesophageal ligament and its deep penetration of the oesophagus to provide a ring of mucosal fixation, (*b*) external anatomy of the cardia showing diaphragm (D), phreno-oesophageal ligament (L), peritoneal reflection (P) and bare area of left gastric pedicle (B) Left lateral view

left gastric vessels through to the mucosa of the cardia, concentrated mainly in the posterior quadrant of its circumference. It is confined between pleura and peritoneum to which it is loosely bound by areolar tissue and fat Heavy deposits of this fat posteriorly may form a "sentinel lipoma" to herniation, as seen so frequently with inguinal hernia. When the ligament is elongated equally throughout its circumference a sliding hernia with reflux results; but if the weakness is confined to one sector a

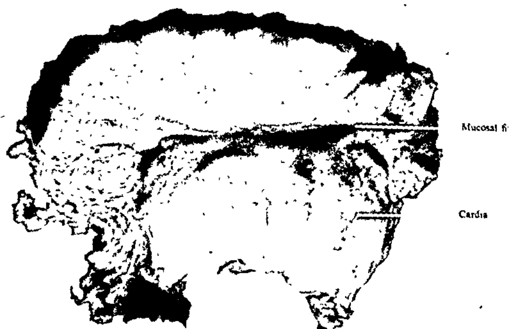


FIG 37—Submucous injection of fluid at the cardia showing the circle of mucosal fixation to the phreno-oesophageal ligament

para-oesophageal hernia occurs without necessarily displacing the cardia, and so co petence is usually retained.

The oblique gastric muscle and cardiac mucosa

These together form the deepest links in the cardia mechanism. All muscu mucosal attachments in the area and the distribution of the oblique muscle fibres a best demonstrated after fresh specimens have been boiled to the consistency of tri to facilitate dissection

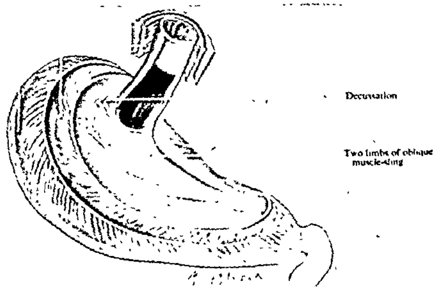


FIG. 38—Anatomy of the oblique muscle.

The oblique gastric muscle

This muscle lies deep to the circular and longitudinal muscle layers and, unlike these, it has no counterpart in the oesophagus with which it can establish continuity. Instead it is firmly attached to the circle of oesophageal mucosal fixation from which it obtains a fixed point for its activity, as well as some purchase from the decussating fibres which loop over the incisura between the fundus of the stomach and the oesophagus (Figs. 38 and 39). As these fibres sweep down the stomach they gain some attachment to the surrounding mucosa, then become concentrated into anterior and posterior bundles along the upper half of the lesser curvature There they are firmly



(*a*)



(*b*)

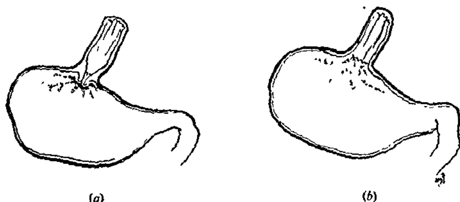
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united to the gastric mucosa by a broad *line of fixation*, corresponding with the magenstrasse, and starting 2–3 centimetres below the cardia but gradually fading out towards the pyloric extremity. Elsewhere the gastric mucosa is noted for its free mobility over the gastric muscle which permits formation of thick rugae.

Of these attachments of the oblique muscle the fixed one is oesophageal and, with each increase of gastric tone, mucosa is drawn up towards it, causing a redundant mucosal fold to encircle the cardiac orifice. When it relaxes, as it does to some purpose in the atonic first phase of the vomiting reflex, this frill of redundant mucosa is stretched out and the cardiac orifice is transformed from a *pouting rosette into an open funnel*. It is common to find this muscle erroneously described as pulling the cardia down when in fact it lifts the gastric mucosa up. Its action is the reversed counterpart of the detrusor of the bladder in which relaxation produces continence but contraction initiates micturition.

The submucosa round the cardia

At the cardia this layer has a special abundance of elastic tissue which elsewhere is relatively sparse. This gives it an elastic quality of extra recoil, which helps to form the mucosal rosette in conjunction with contractions of the oblique gastric muscle



(*a*) (*b*)

Fig 40—The mucosal rosette round the cardia. (*a*) during contraction of the oblique gastric muscle, (*b*) relaxed in preparation for vomiting

(Fig. 40). Together they provide the fine adjustment of the cardia mechanism whilst the diaphragm provides the coarse control as well as the fixed point from which the fine adjustment is made.

When herniation takes place the two parts of the mechanism lose their alignment, and when the pouch of stomach within the chest is inflated by abdominal straining into its usual globular shape the mucosal folds are obliterated by distension into the position required for vomiting or free reflux.

Function

From a functional point of view the cardia mechanism is fully automatic, being controlled by gastric tone and the efforts of the diaphragm which always contracts with the other abdominal muscles in straining. There is, however, experimental evidence from cats which indicates the presence of a reflex stimulation of the fine adjusting mechanism. This is initiated by gastric acid in the lower oesophagus, mediated through the vagus nerves to cause immediate increase in gastric tone in which the oblique muscle plays its part by enfolding the gastric mucosa round the cardiac orifice. If this were confirmed in human subjects it would form a further embellishment to this intricate mechanism required for the protection of the oesophagus from potent juices which are an inherent part of our carnivorous existence.

RESTORATION OF COMPETENCE

Most commonly incompetence is caused by herniation of the cardia out of its normal relationship to the diaphragmatic hiatus, and treatment is concentrated on restoring the normal alignment of these structures. Rarer causes of incompetence, which are mostly temporary, involve neurogenic or mechanical disturbance of the mechanism without displacement, and are secondary manifestations of other gastro-intestinal disease seen principally in the very young and in those subject to peptic ulcers. The cardia may be embarrassed from nearby gastric ulceration, oedema or scarring; it may remain fixed in the position for vomiting over prolonged periods of nausea In these circumstances treatment is aimed at the cause rather than the incompetence, and is usually conservative.

With hiatus hernia, successful restoration of competence is dependent upon two important premises·

(1) Before operation there should be freedom from certain complications of the hernia (2) After operation the readjusted moving part of the mechanism should be left in correct alignment, and in normal working order unhampered by scar tissue or unnatural deformity.

Complications precluding successful reduction

Stricture formation from reflux peptic erosion of the oesophagus

This stricture shortens the oesophagus, destroys mucosal mobility and leaves stenosis with continuing incompetence, even though the cardia may be replaced (perhaps with difficulty) in some instances. Between superficial erosion of the oesophagus and stricture formation there are all grades of damage with no clear dividing line; the extent of damage must be judged at oesophagoscopy, and the chance of a successful reduction thus assessed. It follows that in any large series there must be a proportion of "trial reductions" since the alternative is an extensive operation for resection which is not to be undertaken lightly

The gastric-lined oesophagus

This rare anomaly is always accompanied by hiatus herniation, and operative reduction in these cases is unlikely to succeed since it is being practised on an abnormal cardia mechanism; moreover, the gastric mucosa in the oesophagus remains particularly prone to chronic gastric ulceration with stenosis if this has not already occurred. The condition may be suspected from radiology but is confirmed only by oesophagoscopy

Obesity

Obesity is more of an aetiological factor in hernia development than a complication, but it is also an important factor in causing recurrence, so surgery should be avoided until it has been relieved by dieting, and weight control should continue as an important part of after-care.

Surgical repair of the cardia mechanism

By far the best exposure is obtained through the left chest after removal of the eighth rib. The mediastinal pleura is incised (Fig 41), the oesophagus isolated with both vagi, and a tape passed round it to limit reflux during manipulation, and provide a means of retraction as the repair proceeds. Both margins of the hiatus are cleaned (Fig. 42) The diaphragm is incised anterior to the spleen, avoiding the posterior (hiatal) branches of the phrenic nerve and as many more branches as possible. With

two fingers of the left hand in the hernia sac the stretched components of its wall, phreno-oesophageal ligament and peritoneum, may be trimmed to a frill 1 centimetre wide on the left, anterior and right aspects of the cardia (Fig. 43). The posterior bare area containing the left gastric vessels is left undisturbed apart from removal of a sentinel lipoma of extra-peritoneal fat, if this is present. The tape round the oesophagus is then transposed through the hiatus and its ends splayed apart with slight traction to draw the cardia down

The extent of the divarication at the hiatus is then easily inspected from above. This usually requires one or two loosely tied approximating sutures through the margins behind the oesophagus, and one in front where decussating marginal fibres may seem weak and thin (Fig 44). These are left untied until a later stage to avoid cramping the next procedure of suturing the shortened attachments of the cardia to the under-surface of the diaphragm round the hiatal margins. Through the incised diaphragm about six interrupted silk stitches are placed in a horseshoe arrangement round the cardia, each one picking up peritoneum, phreno-oesophageal ligament and then under-surface of diaphragm (Fig. 45) starting with the first on the right side of the cardia and continuing round the front aspect with successive stitches placing the last on the left side. Meticulous care is required to ensure that the phreno-oesophageal ligament is picked up and identified each time by its firm fixation to the cardia and none of the stitches should be tied until all are in place. The phrenic vessels are near and damage to them should be avoided The loose hiatal approximating stitches are tied and the repair is tested for security with a finger from below before

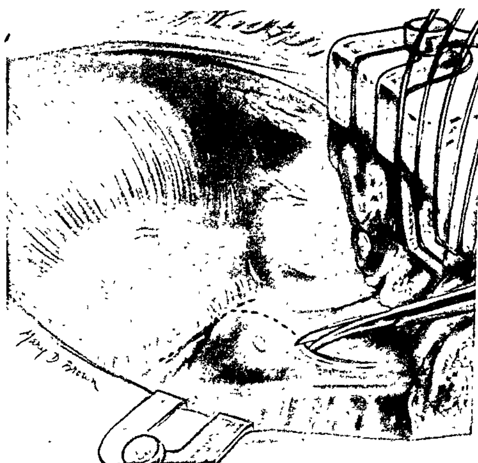


Fig 41.—Mediastinal incision of pleura for exposure of the cardia and hiatus

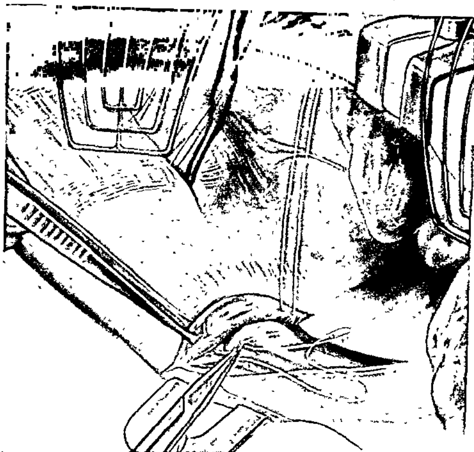


FIG 44 —Approximation stitches for the divaricated hiatal margins. Loosely tied behind and in front of the oesophagus these restore normal size to the hiatus without ischaemic necrosis of this irreplaceable muscle

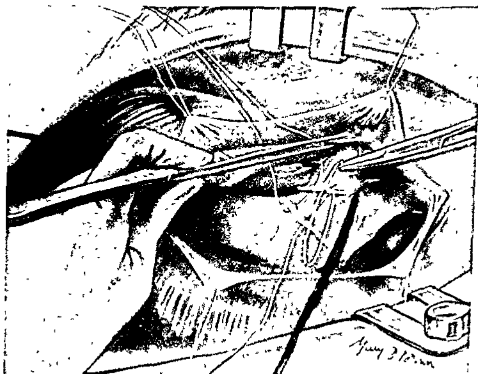


FIG 45 —With interrupted stitches the frills of peritoneum and phreno-oesophageal ligament are stitched to the under-surface of the diaphragm.

PLASTIC PROCEDURES

By JOHN N. BARRON, F.R.C.S.(Ed.)
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THE ABBÉ OPERATION

Abbé in 1898 described an operation for the correction of the flat tight upper lip which may be the sequel of an improper primary repair of a congenital cleft (Fig. 46)

Indications

Similar deformities of the upper lip can be found following excision of tumours, scarring from injury, facial hemiatrophy, noma and syphilis

The operation

The principle of the repair is the transposition of a full thickness flap of tissue containing skin, muscle and mucosa from the lower lip on a small pedicle on the lip margin into the upper lip defect. The pedicle contains the inferior labial artery which provides adequate nourishment for the flap until its new circulation is established. Two stages are necessary and a minimum of two weeks should elapse before the second stage is contemplated.

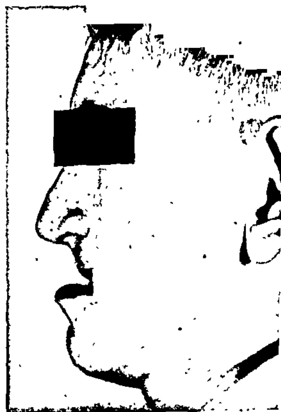


Fig 46—Deformity following improper repair of cleft lip.

Stage one (Figs. 47 and 48)

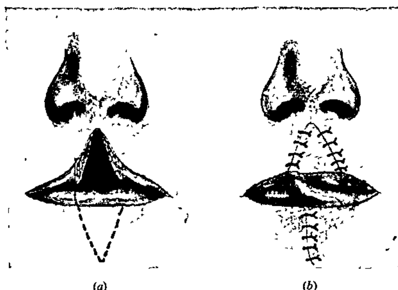
General anaesthesia with naso-tracheal intubation or local anaesthetic may be used.

The true defect in the upper lip is created by excision of scarred tissues and release of tension by division of bands adherent to the upper alveolus. In most cases the defect will assume, or can be made to assume a triangular shape with its apex above.

A triangle of similar size is marked out in the lower lip opposite the defect. This triangle has its base at the lip margin and its apex towards the chin.

The lip is held on each side between the fingers, put slightly on the stretch and with a Bard Parker No. 11 blade it is completely divided through along one side of the triangle so that it is virtually severed in two parts. Bleeding vessels on the lateral lip element are caught with haemostats

The other side of the triangle is then similarly incised from below upwards until the vermilion border is reached. On no account at this level should the labial artery be divided. Haemostasis is effected on the opposite labial lip element and the triangular flap is then ready for transposition



(*a*) (*b*)

FIG 47 —(*a*) Defect in upper lip created by removal of scar Flap marked in lower lip, (*b*) flap transposed into defect

This triangular flap can hinge easily into the upper lip on its small pedicle and when it is in position it is accurately sutured The mucosal layer is stitched first, then the muscle, and lastly the skin

It will be found convenient to put a few mucosal and muscle sutures in the lower lip before the flap is completely inset as this will draw the lower lip together and thus determine the final position of the flap itself.

The lower lip suturing is then completed and the final sutures are put into the vermilion border. No raw area remains and the circulation of the flap should be perfectly satisfactory

Post-operative feeding and removal of stitches.—Feeding is the main problem after this operation and for the first few days a feeding cup is necessary. Later, however, it is amazing to discover that patients are able to manage quite well with semi-solid or even solid foods The stitches are removed on the fifth and sixth days.

Stage two

Two to three weeks later, provided that healing is complete, the pedicle is divided under local anaesthesia and each lip margin is carefully repaired after the small



Fig 48.—Flap healed into upper lip Now ready for severance of pedicle.

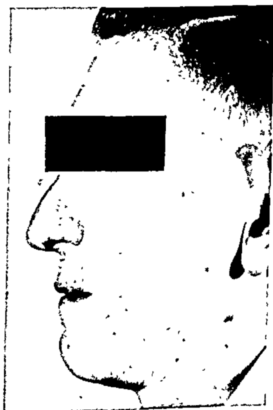


Fig 49.—Improvement in lip length following Abbé operation (*see* Fig 46).

mucosal flaps have been trimmed and inset. If the original suture lines have been accurately placed, the vermilion border of each lip will be well aligned and it will not be difficult to get a smooth contour on the lip margin.

These few sutures are removed on the fourth day, after which no particular treatment is required. It will be noticed that there is no apparent reduction in the horizontal length of the lower lip, and as the scars resolve after a few weeks, a most acceptable result can be expected (Fig 49).

THE BAT OR WINGED EAR DEFORMITY

Indications for treatment

Protrusion of the ears becomes a disability when it is of such a degree that remarks are passed either to the parents of the child, or to the child itself (*see* Fig. 50) It is of course more noticeable in boys as it can be hidden by girls by suitable arrangement of the hair. Nevertheless both sexes are frequently presented for treatment. There is little doubt that the psychological trauma which results from schoolboy ribaldry can have a lasting effect, and may show itself later in life in a variety of abnormal behaviour patterns.

There is thus justification for intervention in these cases. Ideally, operation should be carried out during the fifth or sixth year.

The operation

The method advocated was first described by Luckett (1910) who pointed out that the deformity was due to failure of proper formation of the antihelix. The aims of the procedure are to reform the normal shape of the antihelix and in cases where there is over-development of the concha, to reduce this part of the cartilage to an acceptable size and shape

General anaesthesia with intratracheal intubation is used The child is placed in the supine position on the table with the head resting on a small pillow, or a ring sand bag After thorough soap and spirit cleansing the operation area is towelled off.

An ellipse of skin is marked on the posterior surface with Bonney's blue, the long axis of the ellipse being the line of the proposed antihelix. The upper limit lies just below the rim of the helix at the point where it should be joined by the superior crus of the antihelix and the lower limit is at the level of the antitragus. The maximum width of the ellipse is about 2 centimetres.

The skin markings having been made the tissues on the posterior surface of the pinna are infiltrated with 1 per cent Xylocaine with 1 : 100,000 adrenaline. The ellipse of skin is then excised and the cartilage cleared of soft tissue remnants.

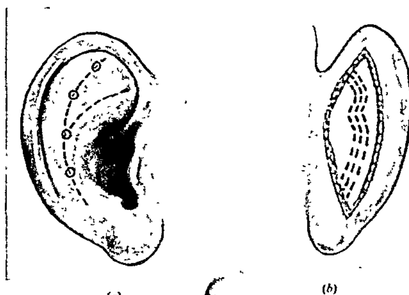
The pinna is then folded back so that a ridge is produced on the anterior surface representing the site of the antihelix This ridge, passing up from the antitragus curves forwards across the scapha until it meets the helix well anterior to the highest point of the pinna. This ridge is marked with ink. In some cases it may be advisable to reconstitute both crura of the antihelix, the line of the inferior crus is also inked in.

In order to mark the posterior surface of the cartilage a straight cutting needle is thrust through in four or five places along the lines marked out, its tip is inked and it is then withdrawn leaving an ink mark in the cartilage itself. Thus the line of the antihelix is projected on to the back of the cartilage (Fig 51*a*)

With the ear held forward three parallel incisions, each 2 millimetres apart, are made along the whole curve of the antihelix so that the cartilage is completely divided without cutting the anterior skin (Fig. 51*b*). The rim of the helix is not cut through as the incisions start about 3 millimetres from it. The ear can then be folded back and the new antihelix will take shape without much tendency to spring. Where there is a large scapha a single cartilage incision in the line of the inferior crus is made to join the previous triple incision



FIG. 50.—Bat ears. Posterior view



In cases where there is over-development of the concha this is now reduced by a crescentic reduction at its free edge and if the antitragus is too prominent its cartilage is similarly reduced in size.

The new position is maintained by putting in three or four horizontal mattress sutures of 4/O silk into the cartilage in either side of the new fold, the stitches passing through half the thickness of the cartilage so that they are not visible under the anterior skin. When all the stitches are in position they are tied and the ear takes up its new shape.

After complete haemostasis has been achieved, the original post-auricular ellipse is closed as a linear suture line with mattress sutures of fine silk.

Dressing

The dressing is of considerable importance to prevent haematoma and oedema. A small plug of Vaseline gauze is placed in the meatus and then pledgets of wool damped in Whitehead's varnish are packed into the conchal cavity, the fossa triangularis, the scapha, and along the sulcus between the helix and the lower part of the antihelix. This forms an accurate mould of all the new contours and preserves the shape obtained at operation.

A wool pad and bandage complete the operation and this is left in position for six days, at which time the post-auricular sutures are removed.

The parents are instructed to put on a head bandage, at night only, for a month to prevent shearing stress while the child is asleep

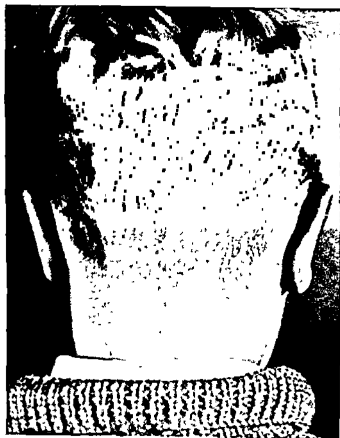


FIG 52 —Result of correction of bat ears



FIG. 53.—Rhinophyma. Note the "butterfly" distribution.



FIG 54.—Corrected rhinophyma

RHINOPHYMA

Pathology

This progressive enlargement of the nose due to hyperplasia of the sebaceous gland elements of the skin is a condition which responds well to treatment. It is not always confined to the nose but may affect a "butterfly" area to include part of both cheeks as well. It is seen in males from the fifth decade onwards and the deformity can become quite grotesque (*see* Fig. 53). A pustular dermatitis is sometimes associated with it and this should be cleared up before operative intervention.

Operation

General anaesthesia with intratracheal intubation is the method of choice and a hypotensive technique greatly simplifies the procedure. Bleeding is the main difficulty and if this can be significantly reduced by the use of one of the hypotensive drugs, visual control of the excision allows much greater accuracy.

The technique advised is to shave away the excess of tissue until a normal size and shape is obtained (Fig 54) A study of the various contours of the normal nose should be made as proper definition of the natural form should be the aim

The excision starts above and is done with a No 10 Bard Parker blade. The edge of the blade soon becomes dull so that as many as six may be necessary; therefore these should be at hand.

When the upper and middle thirds of the nose have been shaved down to an acceptable size, the tip should be carved away to match it, special attention being paid to the columella and alar margins. The supra alar curve should be well defined and the normal fullness of the alar base reproduced. A proper modelling of the various curves of the tip completes the procedure

In most cases no skin graft will be necessary and it is wise to avoid this if possible as natural healing will produce an excellent texture and normal colour.

If, however, the nasal cartilages or large areas of subcutaneous tissue have been exposed a split skin graft should be cut and applied with suitable fixation and pressure dressing.

Post-operative treatment

If no graft is necessary the raw surface is covered with Vaseline gauze which is left undisturbed for 7–10 days when healing will be found to be complete The patient is advised to massage the nose gently with a little lanoline for three to four weeks after operation; if the skin pores are excessively dilated an astringent lotion may be advised to aid resolution.

SADDLE NOSE

Causes

As the name implies this deformity is a depression of the middle third of the bridge of the nose. It is due to loss of support of the nasal septum and this may be brought about by the following factors.

(1) A direct blow on the tip of the nose may fragment the septal cartilage and cause a collapse.

(2) Submucous haematoma of the septum resulting from injury if undrained may result in absorption of part of the cartilage.

(3) Septal abscess which usually arises in a haematoma may cause extensive loss of septal support (Fig. 55).

(4) Saddle nose is sometimes seen as a complication of the operation for submucous



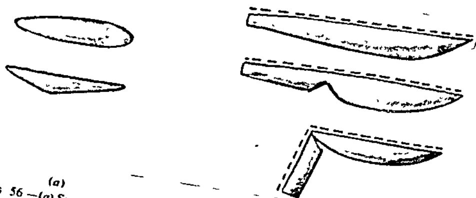
Fig 55 —Saddle-nose deformity following septal abscess

resection for a pre-existing septal deformity Care should be taken in performing this resection not to remove the anterior and inferior parts of the cartilage as these should always be retained for support.

(5) Syphilis, lupus and leprosy, all of which attack the septum, may cause a saddle deformity but in this group the picture is complicated by more or less extensive loss of mucosa in the nasal cavity, and the treatment to be described is not applicable in many of these cases

Indications for treatment

Most patients present themselves for cosmetic reasons, and complaint of a considerable change in appearance may well be justified because the nose is such a prominent feature.



(a) (b)

Fig 56 —(a) Simple "boat-shaped" inlay, (b) hinged cartilage graft for extra tip support.

Loss of bridge support sometimes impedes the airway, as support for the tip is lacking, the alar region droops and interferes with the airstream. Associated with saddle nose there may be a deviation of the remaining septum which is causing the blockage. If there is any doubt as to the cause of the obstruction, the nares can be gently elevated with a nasal speculum and the patient will immediately remark on the improvement in breathing if tip sag is the cause.

Treatment

Any septal deviations or spurs should first be corrected by the standard procedure of submucous resection. Three months should then elapse before correction of the external deformity is undertaken.

Anaesthesia

General anaesthesia with intratracheal intubation is satisfactory. Half an hour before operation the nose is packed with half-inch ribbon gauze soaked in equal parts of cocaine, 10 per cent, and adrenaline 1/1,000, and this may be supplemented by an infiltration of the membranous septum and subcutaneous tissues of the bridge of the nose with a small amount of Xylocaine, 1 per cent, with 1/100,000 adrenaline.

Operation

Autogenous cartilage is recommended as a graft for these cases and this is obtained from the seventh, eighth or ninth costal cartilage. A transverse incision in this region, while not giving the best access, heals with a less conspicuous scar than any other.

The desired cartilage is exposed and removed with its perichondrium in an amount somewhat greater than will be required. The chest wound is closed.

The nose is opened by a vertical incision in the membranous septum on one side and this incision is carried laterally for a short distance between the upper lateral and the alar cartilage.

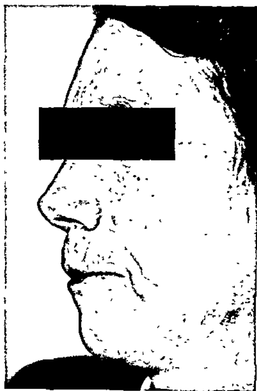


FIG 57 —Saddle deformity corrected by cartilage implant

Normal tip position.—If there is no depression of the tip the two mucous surfaces of the upper septum are gently separated and the bridge of the nose is undermined over the area of depression until a pocket is formed for the reception of the graft. A thorough dissection of the septum without perforation is important as it will afford space for a full sized transplant. Then it will be seen that the cavity produced is roughly boat-shaped and the cartilage is fashioned accordingly (Fig 56*a*) and inserted into its bed If the graft is accurately shaped the deformity will immediately be corrected and the intra-nasal incision is closed with fine catgut sutures.

Depressed tip.—If tip depression is present additional support will be required, and the two layers of the membranous septum should be dissected free from each other to the anterior nasal spine. In this way space is created for the inclusion of an anterior strut of cartilage. The bridge cavity is prepared as described.

In these cases a hinged cartilage graft is used, the bridge piece and the tip support being shaped from a single costal cartilage but they remain connected by a strip of perichondrium. The bridge piece is inserted first and the length of the anterior support is then estimated, the cartilage is trimmed and introduced so that it abuts on the nasal spine. An L-shaped cartilage implant then supports the nose (*see* Fig 56*b*).

Dressing

The whole nose is carefully supported with strips of half-inch strapping so that the soft tissues are held in close contact with the graft A light nasal pack of Vaseline gauze is inserted for twenty-four hours, and the strapping is removed on the fourth day. An illustration of corrected deformity is shown (Fig. 57).

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POLIOMYELITIS: THE DISTRIBUTION OF THE PARALYSIS

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MUSCLE PARALYSIS IN THE ACUTE AND CONVALESCENT STAGES

The initial paralysis

The demonstration of weakness of one or more muscles in a limb is often the first certain indication that a patient is suffering from acute anterior poliomyelitis. The paralysis may progress in one of several ways. As a rule, it reaches its maximum within 48 hours of its appearance; in some cases it may continue to increase in a limb, or appear in other limbs for several days. The return of a normal temperature in most patients determines the end of the spread of paralysis, but it is not safe to assume that no further loss of power will occur until the end of the third week has passed. Watkins (1949) has observed a second wave of paralysis in over 10 per cent of a series of cases, the author has seen two cases in which one upper limb was affected, the patient was allowed to be ambulant at the end of a week and further severe paralysis of both lower limbs developed a week after that.

At the end of the paralytic stage, any combination of paralysis from weakness of one or two muscles in one limb to complete quadriplegia may be present. The severity of the paralysis, fortunately for those extensively affected, is not directly related to the degree of recovery that may ultimately take place. For instance, one limb all of whose muscles are paralysed at the height of the acute illness may show a return of activity in every muscle after two weeks, while the equally affected opposite limb remains completely and permanently paralysed.

The end of the fourth week following the onset of the paralysis is a convenient time at which to make a detailed assessment of the residual paralysis and paresis. The phase of spectacular but irregular recovery is over and, from now on, muscle power increases in a more constant and predictable way.

Muscle testing

The importance of muscle testing has been stressed by Seddon (1954). Except in a few patients who still need continuous artificial respiration in a tank respirator, it should be possible to test the power of all the muscles or muscle groups shown in the muscle charts illustrated in Seddon's article and to grade their power according to the scale approved by the Nerve Injuries Committee of the Medical Research Council, or a modification of it (Table I). The modified scale makes the steps between successive grades more even by introducing an extra grade between Medical Research Council Grades 4 and 5 (normal power) and a more accurate prediction of recovery is possible.

TABLE I

GRADES OF MUSCLE POWER USED IN MANUAL TESTING
(Modified Medical Research Council Scale)

Grade 0	No contraction
Grade 1	Flicker or trace of contraction
Grade 2	Active movement with gravity eliminated
Grade 3	Active movement against gravity
Grade 4	Active movement against gravity and some resistance
Grade 5	Active movement against gravity and considerable resistance
Grade 6	Normal power (within the limits of manual assessment)

The results of the study of muscle recovery by muscle tests made every 2 months for the first year, and every 6 months for the succeeding two years in 149 patients are quoted by Sharrard (1955a).

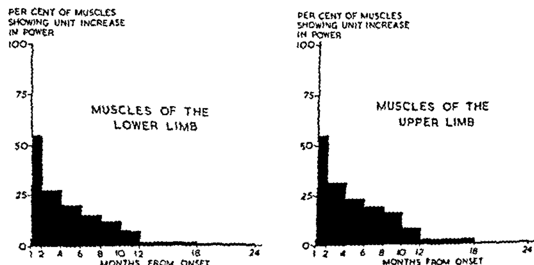


FIG 58.—The rate of recovery in paretic muscles in the lower and upper limb
(By courtesy of the Editor of the Journal of Bone and Joint Surgery)

Recovery of paretic muscles

Paretic muscles, that is, muscles that are active but below normal power by clinical assessment, can *confidently be expected to increase in power* after the first month [illegible]

At the twelfth month, recovery of individual muscles virtually ceases [illegible] further increase in power may result in a few muscles given intensive *muscle training* up to the end of the second year, after this, the only muscles in which any increase in power can occur are those in which the correction of a deformity at a joint allows a muscle previously working at a mechanical disadvantage to function again.

It must be emphasized, though, that two years does not mark the end of *functional* recovery, to which no final date can be given in any one patient.

All paretic muscles in an upper or lower limb make the same mean increase in power in the same way irrespective of their situation in the limb or their distance

permanently, and of those that do recover less than 50 per cent achieve more than a flicker of contraction.

It may be important, especially in the early months, to try to assess whether or not a paralysed muscle can recover. Some indication of the prognosis for a muscle can be obtained by examination of muscles supplied by the same spinal segment. Paralysis of all the muscles is an extremely bad sign; a special example of this is the limb that is completely paralysed or one that shows activity only in the intrinsic foot muscles No muscle ever recovers in such a limb.

An even more specific guide to the future of a paralysed muscle is the state of its associated muscles (*see* Table VIII on p 89). When two or more of them are paralysed the prognosis is bad; when two or more are paretic or normal the prognosis is comparatively good.

CLINICAL DISTRIBUTION OF THE PERMANENT PARALYSIS

The limbs

The series of cases by Lovett (1915) showed an enormous preponderance of paralysis affecting lower limbs compared with upper limbs, and a slightly more frequent paralysis in left than in right upper limbs. In the same series the lower limbs were affected less than twice as often as upper limbs (Table III), and there was no

TABLE III

SITE AND GENERAL SEVERITY OF PARALYSIS IN THE LIMBS OF 149 PATIENTS

Site	*No of cases*	*Severe*	*Moderate*	*Mild*
Right upper limb	66	4	17	45
Left upper limb	60	10	14	36
Right lower limb	108	36	30	42
Left lower limb	103	32	27	44

statistically significant difference between the numbers of affected right and left upper limbs. The number of *severely* paralysed left upper limbs (10) was more than twice the number of severely paralysed right upper limbs (4). It is probable that this difference was due to the effects of inoculation against diphtheria or whooping cough which had been performed during the pre-paralytic phase in 8 children, all of whom suffered a severe paralysis of the inoculated limb which was the left upper limb in 7 cases and the right in 1 case

Paresis and paralysis in the lower limb

At the end of the period of recovery, an affected limb shows a permanent pattern of paralysis At first sight, the distribution appears to be quite haphazard and the pattern to differ in every case; but as early as 1913, Wickman noticed that certain muscles were paralysed more frequently than others. Several later writers, notably Lovett (1915, 1917) and Legg (1929, 1937) in studies of epidemics in Massachusetts, analysed the frequency of paralysis and paresis in the muscles of the lower limb and found a high incidence of paralysis in tibialis anterior, tibialis posterior, the long extensors of the toes and the peronei, a low incidence of paralysis but a greater combined total of paralyses and paresis were present in the quadriceps and the gluteal muscles.

An analysis of 2,464 lower limb muscles confirmed and extended these findings. The quadriceps, hip abductors and inner hamstring muscles lead in *frequency of*

Paresis and paralysis in the upper limb

All who have studied the distribution of the paresis and paralysis in the upper limb have found that the deltoid muscle leads in frequency of affection and of paralysis. Apart from this, there is little agreement in different series, probably because of the small numbers analysed in some cases.

There were 841 upper limb muscles in the series, and an analysis was made in the same way as for the lower limb. The deltoid muscle led in *frequency of affection*, followed by triceps and pectoralis major (Table VI). The least affected muscles were

TABLE VI

FREQUENCY OF AFFECTION OF 841 MUSCLES IN THE UPPER LIMB

Muscle	*Number affected*
Deltoid	94
Triceps	85
Pectoralis major	73
Infraspinatus	68
Latissimus dorsi	63
Thenar muscles	54
Elbow flexors	53
Pronators	45
Extensores pollicis	42
Interossei and hypothenar muscles	42
Wrist flexors	42
Extensor digitorum communis	41
Wrist extensors	40
Trapezius	39
Flexores digitorum	31
Flexor pollicis longus	29
Total	841

TABLE VII

INCIDENCE OF PARALYSIS AND PARESIS IN THE MUSCLES OF THE UPPER LIMB

Muscles (In order of frequency and paralysis)	*Number paralysed*	*Number paretic*	*Ratio of paresis to paralysis*
Thenar muscles	28	26	0 93
Deltoid	25	69	2 8
Interossei and hypothenar muscles	15	27	1·8
Triceps	15	70	4·0
Wrist flexors	14	28	2·0
Infraspinatus	14	54	3·8
Wrist extensors	11	29	2 6
Pronators	11	34	3 1
Latissimus dorsi	11	52	4·7
Elbow flexors	10	43	4·3
Extensores pollicis	9	33	3 6
Pectoralis major	9	64	7·0
Flexor pollicis longus	8	21	2·5
Extensor digitorum cummunis	8	33	4·1
Flexores digitorum	5	26	5·2
Trapezius	2	37	18·5
Total	195	646	

the long flexors of the digits. In frequency of *permanent paralysis* the deltoid muscle was second to the thenar muscles and was followed by the interossei and the triceps (Table VII)

The order of the *ratio of paresis and paralysis* differs from that of the frequency of affection and of paralysis. The intrinsic muscles of the hand (thenar and interosseous) are by far the most susceptible, followed by the muscles acting on the wrist. The deltoid muscle is only moderately susceptible, and trapezius and pectoralis major the least.

Associated paralyses

Mention has been made earlier of the existence of associated paralyses—muscles that tend to be paralysed or spared together. Table VIII lists them in the lower limb. *Some of the muscles are of like function; for instance, the long toe extensors and* peronei or the gluteal muscles. In other associations, such as those between the calf muscle and biceps femoris or between the quadriceps, hip adductors and hip flexors, there is no direct functional relationship and in a few instances, such as that between flexor and extensor hallucis longus, the muscles are antagonists. The *absence* of a strong association between agonist muscles such as the inner and outer hamstring muscles or between the long toe flexors and the intrinsic foot muscles is equally significant.

TABLE VIII

ASSOCIATED PARALYSES IN THE LOWER LIMB

(Muscles in heavy type are *very* strongly associated; those in normal type are strongly associated)

Muscle	*Associated muscles*
Hip flexors (psoas)	**Quadriceps, adductors**
Adductors	Quadriceps, inner hamstring muscles, hip flexors
Quadriceps	[illegible]
Inner hamstring muscles	[illegible]
Hip abductors (gluteus medius and minimus).	[illegible]
Tensor fasciae latae	[illegible]
Gluteus maximus	[illegible]
Biceps femoris	[illegible]
Calf muscles (triceps surae)	[illegible]
Flexor hallucis longus	[illegible]
Flexor digitorum longus	[illegible]
Extensor hallucis longus	[illegible]
Extensor digitorum longus	[illegible]
Peronei	[illegible]
Tibialis anterior	[illegible]
Tibialis posterior	[illegible]
Intrinsic foot muscles	[illegible]

In the upper limb, associated paralyses of the same kind are found, for instance, between the deltoid muscle, the spinati and flexor carpi radialis, a complete analysis is still being worked out.

PATTERNS OF PARALYSIS IN THE LOWER LIMB

The patterns of paralysis that result from the division of a peripheral nerve at any level are clear cut and relatively constant. Except in partial nerve lesions, each muscle in the affected limb is either completely inactive or normal.

The position in poliomyelitis is very different. Paretic muscles of different grades of power lie side by side with paralysed or normal muscles without relation to the distribution of peripheral nerves and, at first sight, the disposition of the paralysis seems to be quite fortuitous. In a sufficiently large series of cases the same patterns of paralysis are repeated sufficiently often to suggest that a mathematical analysis would be worthwhile.

Method

Muscle charts of 500 lower limbs provided the material. The number of muscle groups analysed was 12, 6 above and 6 below the knee and they were rated as either

paralysed (Grades 0 and 1), or acting (Grades 2–6). With this simplification the number of theoretically possible patterns of paralyses in the lower limb is 4,096; if the muscles above or below the knee are taken independently, 64 combinations can occur in each limb segment. The incidence of each of these combinations that might be expected from a random distribution of the 6,000 muscles was calculated and compared with the incidence observed in the 500 limbs.

Results—muscles below the knee

Of the 64 possible patterns of paralysis, 20 were found, 11 of them being majo[r] patterns and the remainder variants of them. Since it is the pattern of the paralysis in the muscles below the knee that determines the liability to deformity in the foot, especially in a child, the deformity to which each pattern predisposes is indicated below.

(1) *Severe paralysis*

(*a*) *Paralysis of all muscles below the knee (74 cases).*—This is the commonest pattern. In over 80 per cent of the cases it is associated with paralysis of all, or all but one, of the remaining muscles in the lower limb

The resulting deformity is negligible or at most a slight equino-varus due to the action of gravity.

(*b*) *Paralysis of all muscles below the knee except the intrinsic foot muscles (44 cases)*—In over 50 per cent of the cases it is associated with severe paralysis of muscl[es] above the knee. The resulting deformity is a mild metatarsus varus and flexion of t[he] toes at the metatarso-phalangeal joints

(2) *Paralysis of inversion*

(*a*) *Isolated paralysis of tibialis anterior (56 cases).*—In 42 cases this was the only paralysed muscle in the lower limb When the tibialis anterior is the only muscle below the knee that is paralysed and one or more muscles above the knee are also paralysed, the quadriceps is always affected.

The resulting deformity is sometimes a medial cavus (Pilcher, 1955) with depression of the head of the first metatarsal produced by the combined action of peroneus longus and an over-acting extensor hallucis longus; sometimes there is a mildly valgus forefoot, and in others no deformity at all

(*b*) *Paralysis of tibialis anterior and posterior (55 cases)* —This frequent combination of paralysis may or may not be associated with paralysis of muscles above the knee; if such is the case, one or more of the quadriceps, adductors, or hip flexors are paralysed. The resulting deformity is usually a valgus foot of variable severity.

(*c*) *Paralysis of tibialis anterior and long toe flexors (23 cases).*—This is a slight variant of isolated paralysis of tibialis anterior. In 50 per cent of the cases these were the only two paralysed muscles in the limb.

(3) *Paralysis of dorsiflexion*

(*a*) *Paralysis of the tibiales and long toe extensors (12 cases).*—This differs from the last group in that the main effect is to cause a drop-foot. The resulting deformity is a valgus or equino-valgus foot.

(*b*) *Paralysis of the tibiales and long toe flexors and extensors (9 cases)* —This is a slight variant of the above group.

(4) *Paralysis of dorsiflexion, inversion and eversion*

(*a*) *Isolated action of the calf (triceps surae) and intrinsic foot muscles (23 cases)* —This is a further extension of the last pattern, in that there is paralysis of the tibiales, long toe flexors and extensors and peronei, it is titled in respect to the muscles tha[t] are acting to draw attention to the severe and intractable deformity that always occurs. The tendo achillis in the absence of the peronei is a slight invertor of the heel; in time, a fixed inversion deformity of the heel develops. The tendon acts in the fashion

(10) *Isolated paralysis of the long toe flexor muscle (6 cases)*

This is a rare pattern which does not give rise to significant disability or deformity. As a rule there are no other paralysed muscles in the lower limb.

(11) *No paralysis in muscles below the knee*

In 110 cases no muscles below the knee were paralysed. In many there was so relative weakness of one or other muscle group corresponding to one of the patter of paralysis already described and showing a liability to the same deformity in milder way. In more than 50 per cent no muscles above the knee showed complet paralysis.

As important as the existence of patterns of paralysis is the finding that, in the 500 limbs, 44 possible combinations of paralysis below the knee never occurred and that most of the patterns recorded above occurred more frequently than would be expected. Combinations in which the intrinsic foot muscles are paralysed are particularly uncommon unless two or more of the other muscle groups in the foot are also paralysed, and combinations in which the tibiales are acting in the presence of paralysis of other muscle groups are infrequent.

Results—muscles above the knee

Compared with the ankle and foot, the hip and knee joints, if correctly treated, are less subject to secondary deformity due to muscle imbalance; on the other hand, paralysis in muscles above the knee leads to greater functional disability. The classification of patterns of paralysis above the knee is therefore based on the mai functional disability that results in each pattern.

(1) *Severe paralysis*

(*a*) *Paralysis of all muscles above the knee (70 cases)*—As in muscles below the knee, the commonest pattern is that in which all the muscles are paralysed. In 60 per cent of the cases all, or all but one, of the muscles below the knee were also paralysed.

Ability to walk depends on the activity of the trunk musculature, particularly of the quadratus lumborum, and on the state of the other limbs.

(*b*) *Isolated action of the adductors (6 cases)*—An uncommon pattern. The adductors are seldom stronger than Grade 2 and there is nearly always an associated severe paralysis in muscles below the knee.

Functional ability is the same as if there was a complete paralysis of all the muscl above the knee.

(*c*) *Isolated action of the hip flexors (13 cases)*—A pattern also associated with severe paralysis in muscles below the knee. Functional ability is slightly better than in the previous patterns because the limb can be swung forwards.

(*d*) *Isolated action of the gluteus maximus (19 cases)*.—This pattern is often associated with active calf and intrinsic foot muscles and with active external rotators of the hip. Unfortunately, the spared gluteus maximus is seldom more powerful than Grade 2 and function is very little better than in a completely paralysed hip and thigh.

(*e*) *Isolated action of gluteus maximus and hamstring muscles (5 cases)*—The gluteus maximus in this pattern is usually moderately strong (Grade 3 or 4) and, with the help of the hamstring muscles, hip extension is fairly powerful. The paralysis below the knee is often a mild one, and, if the calf muscle is also strong, extension of the knee when the foot is on the ground may be good enough to allow a caliper to be discarded in an adult.

(*f*) *Isolated action of hip flexors and quadriceps (3 cases)*—This pattern, though rare, is notable for its liability to produce genu recurvatum even though splints or calipers are used in an attempt to prevent it.

(2) *Paralysis of knee extensors*

(*a*) *Isolated paralysis of the quadriceps* (15 *cases*).—An infrequent pattern, but the second most common isolated paralysis in the lower limb as a whole (6 cases). The associated paralysis below the knee is almost always mild, often only in the tibialis anterior.

Function is remarkably little impaired, and except in a child, in whom a caliper may be necessary to prevent deformity at the knee, external support may be unnecessary for ordinary walking, provided that the muscles can lock the knee in extension

(*b*) *Paralysis of quadriceps and adductors* (13 *cases*).—This pattern differs from the last in that the remaining muscles above the knee are generally a little weaker, and average about Grade 3 in strength. For this reason, a caliper to stabilize the knee is more often required.

(3) *Paralysis of knee flexors and extensors*

(*a*) *Paralysis of quadriceps and inner hamstring muscles* (7 *cases*), *and* (*b*) *of quadriceps, inner hamstring muscles and adductors* (8 *cases*).—The functional disability is similar to that in the previous group, though a little more severe because the other muscles above the knee and below it are moderately affected in most cases.

(4) *Paralysis of hip flexors and knee extensors*

(*a*) *Paralysis of hip flexors and quadriceps* (5 *cases*) —In this pattern, the action of "pushing off" by extension of the hip and locking at the knee is retained, but the inability to swing the limb forward and to extend the knee actively produces an ugly gait. Since the associated paralysis below the knee is often mild, the functional ability can be fairly good in spite of the poor gait.

(*b*) *Paralysis of hip flexors, quadriceps and adductors* (4 *cases*), *of hip flexors, quadriceps, and inner hamstring muscles* (5 *cases*), *and of hip flexors, quadriceps, adductors and inner hamstring muscles* (11 *cases*).—Function in these three patterns is like that in the previous pattern. The paralysis below the knee is usually more severe, and, in the absence of adequate calf muscles, locking of the knee in extension is difficult. A caliper to stabilize the knee may therefore be needed.

(5) *Paralysis of hip abduction or hip extension, or both*

(*a*) *Isolated paralysis of hip abductors* (7 *cases*), *and of hip abductors and hamstring muscles* (3 *cases*) —In both patterns, the disability, apart from a Trendelenburg gait, is not great Paralysis of the hamstring muscles in the presence of an active quadriceps is very likely to produce a genu recurvatum deformity in a child

(*b*) *Paralysis of hip abductors, hamstring muscles and quadriceps* (4 *cases*).—The disability at the hip is the same as in the two preceding patterns; the quadriceps paralysis added to it gives an unstable limb for which a caliper is usually required.

(*c*) *Paralysis of hip abductors, gluteus maximus and biceps femoris* (7 *cases*).—Paralysis of these muscles is associated with patterns of paralysis below the knee in which the calf and long toe flexor muscles are paralysed. Although the intact quadriceps and hip flexors make it possible to walk without a full caliper, a Trendelenburg gait is inevitable, and if the abdominal muscles are weak or paralysed an ugly increase in lumbar lordosis develops. If the acting hip flexors and adductors are strong and the small rotators of the hip paralysed, the hip may dislocate; this tendency is aggravated if the neck of the femur develops a valgus deformity (Blundell Jones, 1954).

(*d*) *Isolated action of hip flexors and adductors* (6 *cases*).—The problem is the same, but rather greater than the last pattern. The paralysis below the knee is usually severe and a caliper is essential. Dislocation of the hip also occurs in this pattern.

(6) *Paralysis of hip abduction and adduction*

(*a*) *Paralysis of hip abductors and adductors and quadriceps* (3 *cases*), *and of hip abductors and adductors, quadriceps and hamstring muscles* (2 *cases*).—The associated

paralysis below the knee is moderately severe. Functional ability with an ischial-bearing caliper is usually fairly good

(7) *Paralysis of hip flexion and abduction and knee extension*

(*a*) *Paralysis of hip flexors and abductors and quadriceps* (1 *case*), *and of hip flexors and abductors, quadriceps and inner hamstring muscles* (3 *cases*).—Rare patterns in which there is considerable disability, the active gluteus maximus and adductor muscles being inadequate to allow walking without the aid of a caliper.

(8) *Isolated paralyses*

(*a*) *Isolated paralysis of hip adductors* (4 *cases*), *of biceps femoris* (7 *cases*), *and of hip flexors* (3 *cases*).—None of these produce any very significant disability.

(9) *No paralysis in muscles above the knee* (265 *cases*)

As in the muscles below the knee, there were many cases with a weakness in one or two muscles, particularly in the quadriceps or the hip abductors. In general, the less the paralysis above the knee, the milder it was below the knee.

Over 50 per cent of the combinations of paralysis that could theoretically exist never occurred in the 500 limbs. Combinations in which the gluteus maximus is paralysed are rare unless three or more of the other muscles above the knee are also paralysed, and combinations in which the quadriceps is acting when the other muscles are paralysed are infrequent.

The number and variety of patterns recorded above may perhaps be rather bewildering to those whose contact with cases of poliomyelitis is limited to a few in every year. Nevertheless, the eleven groups of patterns below the knee and nine above it certainly do not amount to more than all the combinations of paralysis that can result from lesions in peripheral nerves from the level of the cauda equina to the digital nerves of the toes.

THE PATHOLOGICAL BASIS OF THE MUSCLE PARALYSIS

The analysis of affected limb muscles (Lovett, 1915) showed, as do Tables IV and VI, a tendency for muscles nearest the trunk to be more frequently involved than the distal ones. He therefore concluded that differences in the function and size of proximal and distal muscles were responsible. If this were true, the same muscles should suffer paralysis in the same order of frequency, but Tables V and VII show a completely different order.

The observation by Russell (1947), that exercise in the pre-paralytic stage of poliomyelitis increases the severity of the paralysis, has given rise to further speculation on the relationship between fatigue in individual muscles and their liability to paralysis. While a limb as a whole may suffer more severely, it cannot be said that the muscles in the upper half of any of the Tables IV–VII are singled out by fatigue in ordinary activities, nor can dissociated paralysis in muscles of the same type, size and function, such as the inner and outer hamstring, be explained by such a mechanism.

As Skinhoj (1949) observed in a similar study, there is no quality of muscle such as size, function, position in the limb or phylogenetic development that can satisfactorily explain all the features of the clinical distribution of the paralysis, nor does it correspond to the innervation of muscles by peripheral nerves. There remains the possibility that it may be related to the nature of their innervation from the motor nerve cells of the anterior horn of the spinal cord.

SEGMENTAL INNERVATION IN RELATION TO AFFECTION OR PARALYSIS OF MUSCLES

Evidence of a relationship between muscle affection and spinal segmental nerve supply is given by curves, derived from Tables IV and VI, of the *segmental incidence*

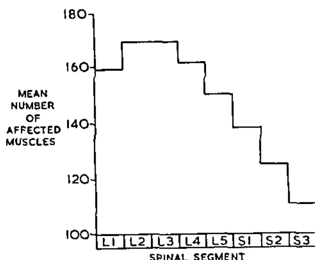


Fig 60 —The segmental incidence of affection of muscles in the lower limb
(*By courtesy of the Editor of the Journal of Bone and Joint Surgery*)

of muscle affection. In the lower limb (Fig. 60) the highest incidence is found in the second and third lumbar segments, below this level, there is a uniform decrease in [illegible] of affected muscles that successive spinal segments supply

the

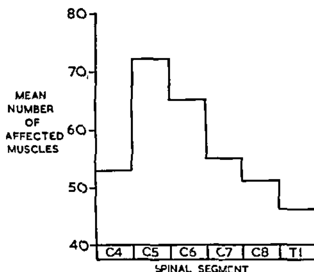


Fig 61 —The segmental incidence of affection of muscles in the upper limb
(*By courtesy of the Editor of the Journal of Bone and Joint Surgery*)

THE SPINAL CORD IN THE NORMAL AND POLIOMYELITIS

Attempts by earlier authors (Lovett, 1915, Skinhoj, 1949) to explain their clinical findings in terms of spinal cord lesions were hampered by the paucity of information concerning the localization of function in the motor cells in man and by the incomplete accounts of the sites of destruction of these cells in poliomyelitis.

In 1950, a study of normal and poliomyelitic spinal cords was begun; the results,

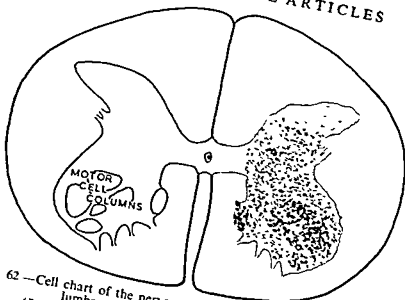


FIG 62.—Cell chart of the nerve cells in the grey matter of the third lumbar segment of a normal spinal cord.
(By courtesy of the Editor of the Journal of Bone and Joint Surgery.)

a summary of which will be given here, account for all the clinical phenomen
muscle affect, paralysis, association of paralysis and patterns of paralysis descri
above.

Method of study

The principles underlying the study of the spinal cord in poliomyelitis are simpl
Spinal cords were obtained from seven patients who had died at intervals varyin
between three months and eight years after the onset of the disease. The level of

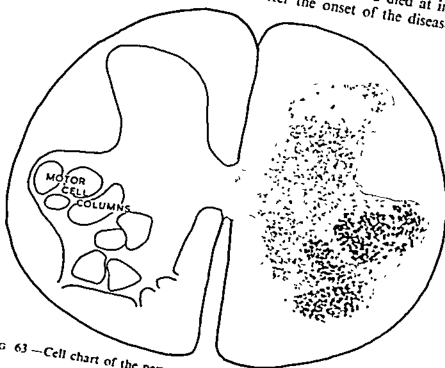


FIG 63.—Cell chart of the nerve cells in the grey matter of the fifth lumbar segment of a normal spinal cord.
(By courtesy of the Editor of the Journal of Bone and Joint Surgery.)

The second and third lumbar spinal segments were the most frequently and extensively attacked in all the cords. Segments caudal to this were less often affected, the third and fourth sacral segments being especially likely to be spared. A similar segmental incidence of motor cell destruction has been noted by others (Horanyi-Hechst, 1935; Peers, 1943; Elliott, 1945, 1947).

Destruction was found not to be diffuse but localized in discrete foci of varying length and width with interposed lengths of grey matter of more normal cell content. An example of this is shown in Fig. 64, which represents the longitudinal distributio of the lesions in one of the spinal cords, reconstructed from more than 300 ce charts.

In the transverse plane the centre of the anterior horn appeared to be the mos vulnerable area at most segmental levels. The fifth lumbar segment, in which the anterior

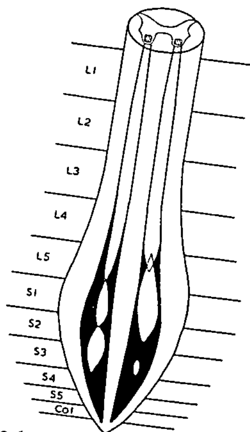


FIG 64—A longitudinal analysis of the destruction of motor cells in the lumbo-sacral cord in a case of poliomyelitis with a moderate bilateral paralysis of the lower limbs Regions shown in black contain residual motor cells Note the complete absence of cells in the upper lumbar spinal segments and the focal loss in the lower lumbar and sacral segments
(By courtesy of the Editor of the Journal of Bone and Joint Surgery.)

horn has its greatest transverse area, demonstrated this central loss very clearly; the example shown in Fig. 65 was typical of that found in many cell charts in the poliomyelitic cords at this level.

Motor cell destruction was always much more severe than would have been expected. One case in which there had never been any demonstrable weakness in any muscle in the lower limb had suffered losses up to 40 per cent of the normal

number of cells in some cell columns. Far from there being any evidence that residual motor cells were functionally inactive, it was surprising to discover how small a proportion of cells had been required to produce a useful contraction in the muscle they supplied. The residual power of a muscle was found to be closely related to the proportion of remaining motor cells that supplied it (Table IX).

TABLE IX

RELATIONSHIP BETWEEN MUSCLE POWER AND RESIDUAL MOTOR CELLS IN THE SPINAL CORD

Muscle power (modified Medical Research Council scale)	Percentage of residual motor cells
0	0–2
1	2–3
2	3–5
3	5–10
4	10–20
5	20–40
6	over 40

Relationship between the distribution of the paralysis and the destruction of motor nerve cells

Affection of muscles

The segmental incidence of muscle affection (Fig 60) derived from the analysis of the clinical material agrees exactly with the general distribution of motor cell destruction described above. Since the upper lumbar spinal segments supply muscles in the region of the hip and thigh, while the lower lumbar and sacral segments generally supply the muscles of the leg and foot, it is easy to see why there is, apparently, a greater incidence of affection in proximal than in distal muscles in the limb. It is interesting to note that the hip muscle that derives its main supply from the

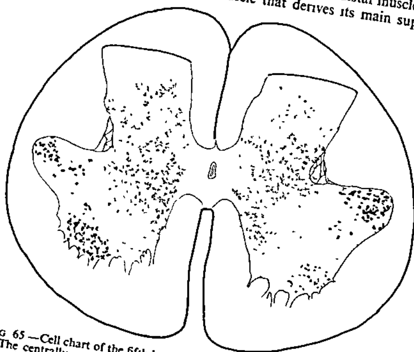


FIG 65 —Cell chart of the fifth lumbar segment of a poliomyelitic spinal cord. The centrally situated motor cell columns have been severely affected on both sides (Compare with the normal in Fig 63)

(By courtesy of the Editor of the Journal of Bone and Joint Surgery)

sacral segments—the gluteus maximus—is less frequently affected than other hip muscles (Table IV). This is also true of the small external rotator muscles of the hip, though they are not shown in the Table.

The findings in the spinal cord also account for the large number of paralyses found in muscles such as tibialis anterior, tibialis posterior and the long flexor and extensor muscles of the toes. In Table X the ratios of paresis to paralysis in individual muscles are compared with the lengths of the motor cell columns that supply them Muscles supplied by short columns of cells are the most frequently paralysed; those supplied by long columns are most likely to be paretic.

Plate II illustrates the probable mechanism responsible for this finding. A focus of motor cell destruction that severely affects the fourth and the upper part of the fifth lumbar spinal segment destroys almost all of the motor nerve cells that supply the tibialis anterior and posterior. All other muscles are left with a proportion of residual motor cells sufficient to maintain normal power as judged by clinical examination.

TABLE X

THE RELATIONSHIP BETWEEN LENGTH OF CELL COLUMN AND THE RATIO OF PARESIS TO PARALYSIS IN MUSCLES IN THE LOWER LIMB

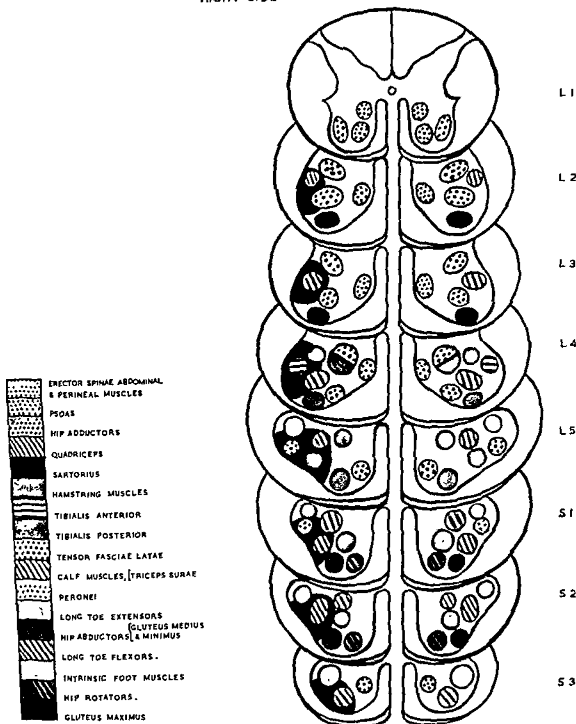
Muscle	*Ratio of paresis to paralysis*	*Approximate length of motor cell column (millimetres)*
Tibialis anterior	0·47	8
Flexor digitorum longus	0·52	8
Tibialis posterior	0·57	8
Flexor hallucis longus	0·58	8
Extensor hallucis longus	0·89	9
Extensor digitorum longus	1·06	10
Peronei	1·10	10
Calf muscles (triceps surae)	1·26	14
Biceps femoris	2·03	14
Hip abductors	2·78	16
Intrinsic foot muscles	2·87	15
Inner hamstring muscles	2·90	20
Tensor fasciae latae	2·92	16
Quadriceps	3·00	22
Gluteus maximus	3·30	17
Hip adductors	3·50	22
Hip flexors	3·67	23

All the features of the distribution of paresis and paralysis are satisfactorily explained in terms of lesions in the spinal cord. All the evidence is against a primary cause in the muscles themselves. If it were true that the distribution of paralysis was related to factors peculiar to certain muscles, movements or activities, evidence of it would be found in the disposition of cell destruction in the spinal cord. In fact, the focal loss of cells is completely independent of the boundaries of any one cell column, parts of cell columns are frequently obliterated in vertical or transverse planes For the same reason, the implication of higher centres as primary factors in the localization of the paralysis is inadmissible.

Associated Paralyses

When the whole of the motor column that supplied a muscle has been destroyed, it is likely that one or more adjacent motor columns that occupy the same length of spinal cord will be completely destroyed or severely affected. This is reflected in the clinical distribution of muscle paralysis. For instance, the columns that supply extensor hallucis longus, extensor digitorum longus and peronei lie next to each other and occupy approximately the same length of spinal cord (Plate I) Paralysis of one of these muscles is, therefore, frequently associated with paralysis of the other two

PLATE I

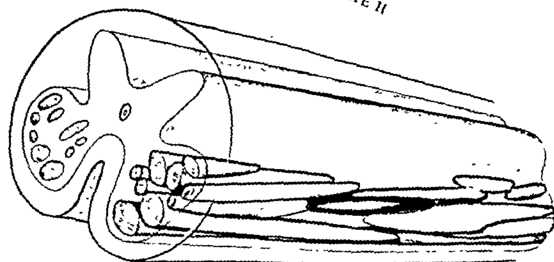


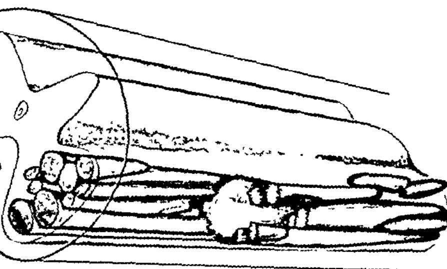
The representation of the lower limb muscles in the motor cell columns of the lumbo-sacral spinal cord The groupings of the columns are those that are the most characteristic in each spinal segment Areas shown in black are those most liable to be affected by poliomyelitis.

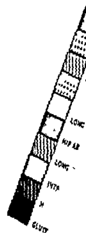
(By courtesy of the Editor of the Journal of Bone and Joint Surgery)

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PLATE II





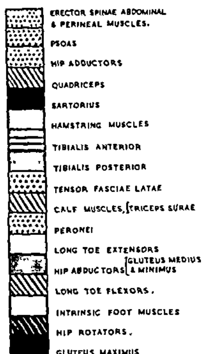


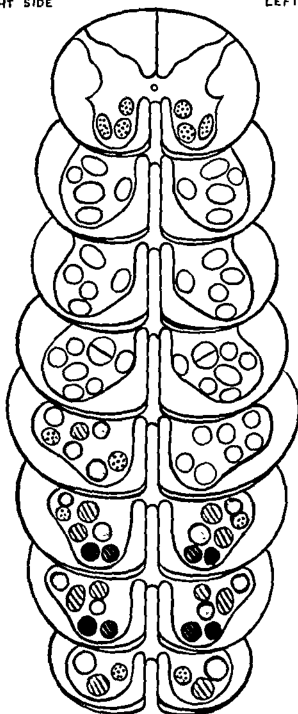
...ell columns of the third, fourth and fifth lumbar segments of the spinal
...otor cell columns are shown, the two columns shown in colour are
... tibialis anterior (blue) and tibialis posterior (yellow) The visible cut
...l end.
... columns in the lower part of the fourth and the upper part of the
... been obliterated by poliomyelitis Only the short columns for the
...ibialis posterior (yellow) have been almost completely destroyed;
... paretic on clinical examination
...f the Editor of the Journal of Bone and Joint Surgery.)

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PLATE III

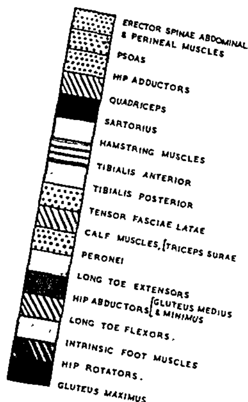


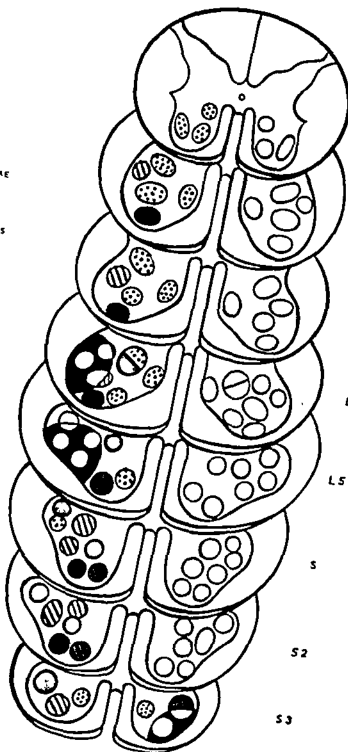


A representation of motor cell loss in the lumbo-sacral spinal cord in poliomyelitis *On the right side* all the cells in the second, third and fourth lumbar segments have been destroyed Cell columns for the quadriceps, hip adductors, sartorius and tibialis anterior have disappeared, these muscles will be paralysed The psoas and tensor fasciae latae retain a portion of their cell columns and will be paretic *On the left side* the second, third, fourth and fifth lumbar segments have been destroyed The cell columns for the quadriceps, hip adductors, sartorius, tibialis anterior and tibialis posterior have disappeared, these muscles will be paralysed The hip abductors, semimembranosus, long toe extensors and peronei retain a portion of their cell columns and will be paretic.

(By courtesy of the Editor of the Journal of Bone and Joint Surgery)

PLATE IV





A representation of motor cell loss in the lumbo-sacral spinal cord in poliomyelitis *On the right side* a partial lesion in the fourth and fifth lumbar segments has destroyed the cell columns for the tibialis anterior and tibialis posterior All other muscles have retained a high proportion of their cells and the muscles concerned will not be clinically affected. *On the left side* all the cell columns except those in part of the third sacral segment have been destroyed. Only a portion of the column for the intrinsic muscles of the foot remains. The clinical result will be a flail lower limb in which only the intrinsic muscles of the foot are active

(By courtesy of the Editor of the Journal of Bone and Joint Surgery)

[*To face page 101*

(Table VIII). Conversely, absence of paralysis in one muscle is likely to be associa
with absence of paralysis in the others.

Unusual associations, like that between the calf muscles (triceps surae) and
biceps femoris, can be accounted for in the same way and would, indeed, be expect
to occur since their motor cell columns are so closely associated The factor comm
to all strongly associated pairs of muscles is that their motor cell columns l
adjacent to one another and their segmental levels of supply correspond or overlap
With the knowledge of the localization of function in the motor cell columns tha
has been established above, it should be possible to deduce from the level of the
paralysis in the muscles of any lower limb the approximate site and extent of lesions
in the spinal cord, though not with such ease as in the diagnosis of a lesion in a
peripheral nerve. Difficulties arise because, as indicated in Table IX, a muscle is not
paralysed unless the whole of its motor cells column has been affected. Even a residue
of 10 per cent of intact motor cells may permit substantial activity in a muscle, and
these intact cells may lie at the upper end, in the middle, or at the lower end of the
cell column

There is another important difference between the analysis of peripheral nerve lesions and poliomyelitic lesions. Whereas lesions in peripheral nerves are much more often complete than partial in the transverse plane, lesions in the spinal cord frequently only involve part of the width of the grey matter at any given segmental level.

The distribution of muscle paralysis that might be expected to result from the existence of total or partial lesions of varying longitudinal extent in the grey matter of the lumbo-sacral spinal cord can nevertheless be worked out, and, conversely, all the common combinations or patterns of paralysis in poliomyelitic lower limbs can be explained in terms of one or more foci of motor cell destruction.

Plate I shows the position and size of cell columns for the lower limb muscles in the lumbo-sacral cord. The regions of the anterior horn that are shown in black in each segment are those most likely to be affected in partial lesions in the transverse plane. If all the cells in the second, third and fourth lumbar segments are destroyed, only the quadriceps, hip adductors, sartorius and tibialis anterior will be paralysed; the psoas and tensor fasciae latae will be paretic, but other muscles will be normal (Plate III, right side) The pattern corresponding to this loss is 2 *b* in muscles above the knee and 2 *a* below the knee (See pp 90–94). Should the destruction involve the fifth lumbar segment as well, the tibialis posterior will also be paralysed, the hip abductors and semimembranosus will be severely paretic and the long toe extensors and peronei mildly paretic (Plate III, left side) The pattern is then 2 *b* above and 2 *b* below the knee

The common isolated paresis of the tibialis anterior (pattern 2 *a*) results from a partial lesion in the lower part of the fourth and the upper part of the fifth lumbar segments (Plate II) When the tibialis anterior and tibialis posterior are both paralysed (pattern 2 *b*), there is a partial lesion extending throughout both segments (Plate IV, right side)

An extensive lesion that destroys all the motor cells in the lumbo-sacral segments gives rise to a lower limb in which only the intrinsic muscles of the foot and the peroneal muscles are active (Plate IV, left side) This corresponds to pattern 1 *a* above and 1 *b* below the knee

These few examples demonstrate how, by various combinations of destructive lesions in the grey matter of the spinal cord, the distinctive patterns of paralysis in poliomyelitis may be explained

THE PRACTICAL APPLICATION OF THESE FINDINGS

The clinical and pathological results recorded here can be applied in the management of all stages of poliomyelitis.

Diagnosis

In the diagnosis of poliomyelitis, at an interval after the acute stage, or when no febrile illness has been observed, the distribution of the paralysis alone may differentiate it from other lower motor neurone diseases. The paralysis in poliomyelitis is rarely precisely symmetrical So frequently are the hip abductors, quadriceps or tibialis anterior affected that absence of paresis or paralysis in any of them in the presence of paralysis in other muscles in the lower limb makes a diagnosis of poliomyelitis unlikely. By contrast, in peroneal muscular atrophy the muscles most frequently affected in the early stages of the disease are the intrinsic muscles of the feet and peronei, a combination of paralysis rarely seen in poliomyelitis.

Aparalytic poliomyelitis

The quantitative relationship between the loss of motor nerve cells and the residual power in muscles is particularly important in cases regarded as aparalytic in the acute stages of poliomyelitis. Although there may never have been any clinical paralysis, a considerable proportion of motor cells may have been damaged or destroyed. The nerve supply to some muscles, especially those supplied by short cell columns, may have been diminished by up to 60 per cent Patients without any paralysis are frequently allowed to walk within two or three weeks of the onset of the major illness. It is known that over-stretching or over-fatigue can occur in muscles such as the hip abductors and tibialis anterior and may result in deterioration in power (Lovett, 1915, 1917; Sharrard, 1955a). Paresis, previously undetectable, may be revealed later by the development of a limp or a valgus foot It is probably wise, therefore, not to allow the resumption of full activity in an aparalytic case at too early a date, and to continue to look for evidence of paresis over a period of not less than six months.

Prognosis

Table II can be used to assess the prognosis in paretic muscles up to the sixth month and Table VIII to indicate the possibility of recovery in paralysed muscles in the early months. After the sixth month it is unfair to patient and physiotherapi to continue specific treatment to paralysed muscles that will never recover any usef power.

Convalescent stage

The results can be used to aid in planning the treatment of the paralysis in a limb. For instance, in an adult, a caliper may be needed to give stability to the knee (in a child it may be required, in addition, to prevent deformity) In an adult lower limb in which the quadriceps acts at Grade 2 four months after the onset of the paralysis, it would be reasonable to postpone the prescription of a caliper in the expectation of recovery in that muscle to a level (Grade 3) sufficient to give stability to the knee joint. In another limb in which the quadriceps is completely paralysed, the pattern of paralysis is probably that illustrated in Plate IV Treatment should be planned in the expectation that the quadriceps will remain paralysed and a caliper should be prescribed.

Muscle imbalance

It is widely believed that if there is inequality of muscle action at a joint, as, for example, when the triceps surae is paralysed to Grade 1 and the dorsiflexors of the ankle are acting at Grade 3, the progress of recovery may restore the balance, the weaker muscles being able to "catch up" with the stronger ones. Unfortunately, this never occurs, for both muscle groups recover at the same rate and to the same degree, maintaining the disparity between each other The situation is even worse when one

of the muscles is paralysed and remains so; the paretic muscle increases in strength and the disparity between them is made worse.

Anticipation of deformity

After the sixth month the pattern of paralysis is well established; in most cases, it can be placed in one or other of the subdivisions already described and the cell loss that has occurred in the spinal cord can be visualized. Where there is an im- loss of balance between opposing muscle groups [illegible] knee, the appropriate deformity [illegible] the reserv[illegible] develo[illegible] and at [illegible] in different individuals

ACKNOWLEDGEMENT

The author is indebted to the Editor of the *Journal of Bone and Joint Surgery* for permission to quote extensively from that journal.

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THE TREATMENT OF RECTAL PROLAPSE

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Since the earliest days prolapse of the rectum has excited the interest and taxed the ingenuity of surgeons and until the last century it was treated by fanciful ointments and curious devices designed to retain the bowel in place. The condition may be partial or complete, the first indicating a prolapse of mucous membrane only outside the anal orifice; the second a prolapse of the whole thickness of the rectal wall.

PARTIAL PROLAPSE

This may occur in infancy, when prolapse may also be complete; in adult life, when it may seem to be little more than an exaggerated degree of pile prolapse; or in the elderly, when, particularly in women, it may be associated with a lax sphincter and some degree of incontinence.

Prolapse in infancy

More cases occur during infancy than at any other age. It is said that the sacral curve is less marked in the child and the rectum less securely attached to the front of the sacrum. Chronic diarrhoea, loss of weight and debilitating diseases are all regarded as contributing causes but in the majority of cases the condition probably results from a child with irregular bowel habits or constipation being allowed to sit upon a chamber with periodic straining for a prolonged period.

Treatment

The mother should be instructed to give the child a diet with plenty of roughage and ensure a regular bowel routine after breakfast with the aid of liquid paraffin or milk of magnesia. If the prolapse appears it must be replaced at once. If it is of any size, or the mother appears unable to handle the situation, the child should be admitted and initially its bowels may be opened lying on its side with the aid of suppositories or small enemas. It is seldom that the discipline of a children's ward does not cure the condition but if conservative measures have failed, scattered high submucous injections of carbolic oil may be given or the rectal mucosa lightly cauterized by three or four linear incisions carried out under anaesthesia. After both these measures, which are designed to fix the redundant mucosa to the underlying muscle wall, the child should be retained in hospital for a fortnight under the same conservative measures

Partial prolapse in adults

There are two main types of this condition in adults and the distinction between them is important. In the one the prolapse is associated with normal sphincter tone; in the other the sphincter is lax and there is frequently some degree of incontinence.

Mucous prolapse with a normal sphincter

The majority of these cases occur in elderly women and when it occurs in men it may be associated with prostatic obstruction. The condition is similar to haemorrhoids

with a severe degree of prolapse. There is seldom much pain but the patient finds it impossible to avoid staining the undergarments and occasionally the mucous leak may be responsible for a pruritus. Palliative treatment by high submucosal injections may be tried but operation gives quicker and much more satisfactory results. Age and general condition need seldom be regarded as a bar to operation, for if desirable it can be performed under a local anaesthetic. The operation consists in picking up the redundant mucous membrane in the three main pile areas, incising the muco-cutaneous junction and transfixing each portion as in a pile operation. While it is desirable to remove sufficient, it is important not to strip up the pedicles too high or scarring may result in a stricture. The after-treatment includes the regular use of an anal bougie until all granulating areas have healed.

Mucous prolapse with anal incontinence

These cases constitute, perhaps, the most difficult problem in rectal prolapse. The patient's primary complaint is usually of the incontinence and not of the prolapse. The incontinence varies; it is not complete but as the occasional accident becomes more frequent the patient is never certain whether the rectum will leak or not. There is a patulous anus with a very poor sphincter tone The anus can be closed voluntarily against the passage of a finger but once the voluntary contraction is over it again relaxes. A ring of mucosa descends on straining but the prolapse is seldom marked and the condition does not seem to be a stage in the development of complete rectal prolapse.

Gabriel (1948) has described the shortened anal canal that is found in these patients and the appearance of the mucous membrane almost contiguous to the anal verge. The majority of these patients are elderly women but childbirth seems to play no part in the history and there is seldom evidence of perineal damage. Gabriel regards the condition as due to failure of normal sympathetic control of the internal sphincter, caused possibly by fatigue and exhaustion through purgation over many years. Whatever the cause it is a most difficult condition to treat.

Treatment

Excision of the mucosal prolapse is not likely to benefit the patient if the sphincter is lax and indeed it must be recognized that while this type of case may improve considerably under treatment it cannot be completely cured. Initially the best course is to admit the patient to hospital, treat her with scattered high mucosal injections [illegible]
[illegible]
[illegible]
inserted in the perianal tissues. There is little risk in the operation and in frail or elderly patients it may be of great benefit

COMPLETE RECTAL PROLAPSE

Though the condition is actually more common in children, such cases seldom require more than the conservative or minor operative measures already outlined. In adults the treatment is much more difficult. It is said that complete rectal prolapse was not uncommon in concentration camps during the last war when loss of weight, muscular weakness and dysentery were probably the predisposing factors. Under ordinary circumstances the condition is much more common in women than in men, though again childbirth or perineal injury do not seem to be the cause.

Conditions present in complete rectal prolapse

Normally the rectum lies in the curved hollow formed by the sacrum, the coccyx and the extension forwards from the coccyx of the central raphe of the levator ani



FIG. 66.—Rectum outlined by barium in a normal female in the erect position demonstrating its adherence to the sacral curve and the almost horizontal position of the rectum from the coccyx forwards to the anal canal.

(Reproduced by courtesy of the Editor of Proc R Soc Med)



FIG. 67.—The normal position of the rectum following the sacral curve demonstrated by a barium enema in the knee-elbow position.

(Reproduced by courtesy of the Editor of Proc R Soc Med)



FIG 68 —Film in the knee-elbow position of the rectum and vagina outlined by barium in a patient suffering from complete rectal prolapse. (Tip of coccyx marked.) The rectum is widely separated from the sacro-coccygeal curve.

(Reproduced by courtesy of the Editor of Proc R Soc Med)

(Figs. 66 and 67) In a normal female with a good pelvic floor, standing erect, a lateral view after a small barium enema shows that the last part of the rectum is almost horizontal in its direction as it passes forwards to the levator hiatus The vagina lies almost horizontally above it and the cervix is vertically over the coccyx. The rectum

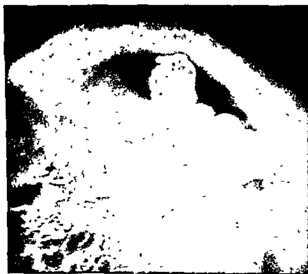


FIG 69 —Film in the knee-elbow position of the rectum

is retained in its position in spite of variations in intra-abdominal pressure by this curve, which permits only a small part of the bowel to lie directly over the levator hiatus, by the fatty tissue around it containing arteries, veins, lymphatics and sympathetic nerve fibres, possibly by condensations of pelvic fascia, though some observers deny their existence, and most important of all by a strong levator ani muscle.

The peritoneum

If laparotomy is performed on a female suffering from complete rectal prolapse, and the interior of the pelvis inspected in a high Trendelenburg position, certain



Fig. 70. [illegible]

features are invariably present. It may be argued whether they are cause or effect but their recognition is essential if operative treatment is to be successful. Instead of lying closely against the sacrum the rectum retains a mesentery, usually short but occasionally up to 2 inches in length. This mesentery is attached loosely towards the left side of the sacrum. If it is pushed to the left the whole of the sacral concavity can be seen covered by peritoneum. The rectum does not lose its mesentery or become attached posteriorly until the sacrococcygeal region is reached and even here its attachment is loose. This curious attachment of the rectum can be demonstrated by lateral x-rays of the patient taken in the knee-elbow position and standing erect after a small barium enema (Figs. 68 – 70). The central part of the pouch of Douglas is particularly deep and passes downwards like a hernial sac between the rectum and the posterior vaginal wall almost to the levator ani (Fig. 71). Most of the posterior vaginal wall is now covered by peritoneum and there is little left of the normal recto-vaginal septum. If pressure is made with a finger on the rectal wall at the bottom of

the pouch of Douglas, it can be inverted through the anal orifice without difficulty. Moschowitz (1912), who gave the first accurate account of the findings in complete rectal prolapse, regarded this deep peritoneal pouch as a true hernia caused by the giving way of the pelvic fascia at this point, but more recently Berglas and Rubin (1953) concluded that there was no evidence of any real fascial sheaths around and between the pelvic organs.

The lateral rectal stalks

These are condensations of connective tissue on either side of the lower rectum, containing fat, vessels, nerves and lymphatics; they are believed to play a part in maintaining its position. In complete rectal prolapse these are loose and attenuated.

The fascia of Waldeyer

It is probable that this is the only true fascia in the pelvis. Lying just above the levators it is fused posteriorly to the front of the sacrum and is attached to the rectum around the ano-rectal region, where the rectum itself passes through the levator hiatus. It is only posteriorly and laterally that this fascia is of any substance. Anteriorly it is thin and not easy to distinguish and it is difficult to believe that operations for rectal prolapse that aim at suturing the fascia in this region can be effective.

The levator ani

The condition of this muscle is probably the most important factor in rectal prolapse and this was recognized by Ambroïse Paré (1634), who drew attention to the prolapse which may follow "a palsie of nerves which goe from the Holy-bone to the Muscles the lifters up of the Fundament". The exact anatomy at the ano-rectal region continues to excite the interest of proctologists but all work has stressed the close attachment of the ano-rectal canal to the pubo-rectalis fibres of the levator ani and the external sphincter muscle. This attachment, which is more marked posteriorly and laterally than it is in front, does not usually prolapse itself and this explains the groove around the presenting rectal prolapse. It has been shown that in the erect position the levator raphe or "plate", that portion of the muscle upon which the rectum lies before reaching the levator hiatus, is almost horizontal. When straining takes place in the normal female, the vagina is forced backwards against the rectum and the rectum is forced backwards against the levator muscle The muscle becomes more oblique but this tendency is restrained by its co-ordinated contraction and particularly by those fibres arising from the pubes. As long as the muscle is efficient, straining tends to compress the rectum antero-posteriorly rather than push it downwards If the levator tone is poor, the picture in the erect position is now very different and in patients who suffer from complete rectal prolapse the line from the coccyx to the levator hiatus, instead of being almost horizontal in the erect position, is now almost vertical (Fig 70) The rectum now lies almost vertically over the levator hiatus and on straining it tends to be pushed down into the hiatus The ano-rectal region is attached at its circumference to the levator but the anterior wall of the rectum at the bottom of the pouch of Douglas comes down first through the anus, followed by the remainder of the prolapse. As this is repeated the hiatus becomes still wider and the muscle still weaker Some of these appearances can be demonstrated by myograms of the levator ani and by barium traces of the rectum (Muir, 1955).

The evidence suggests that weakness of the levator ani is the most important factor in the development of rectal prolapse and that this is more likely to occur if in a patient with a weak levator there is a particularly deep pouch of Douglas The ideals in treatment would seem to be the strengthening or protection of the weak levator ani and an alteration of the anatomy in the pouch of Douglas. Operations designed to strengthen the levator have been performed from above, when the two halves of the levator have been sutured together between the rectum and the vagina,

or from below by a perineal exposure; if the anatomy of the muscle is carefully examined, however, it is hard to believe that such sutures can ever effectively contain the muscle in its new and abnormal situation. If the muscle cannot be directly strengthened, attempts can be made to protect it by preventing the prolapse. This, and alterations to the pelvic peritoneum, can only be performed by an abdominal operation. Recto-sigmoidectomy, the resection of the prolapse from the perineum, cannot achieve the desired object. In the past its use has been followed in many cases by recurrence and incontinence (Thompson, 1949), but because it has a very low mortality it still has a place in the treatment of complete rectal prolapse. It should, however, be reserved for patients unfit for an abdominal operation.

ABDOMINAL OPERATIONS FOR RECTAL PROLAPSE

Moschowitz's original operation, in which the pouch of Douglas was obliterated by sutures, did not prove a success and there have been many variations, in some of which attempts were made to suture the levator ani from above; in others where the rectum was stripped up and resutured in a different position. Lloyd-Davies (1949) advises the formation of a new rectovaginal septum by non-absorbable suture and the tethering of the rectum in position by the use of floss-silk slings attached to the sacro-spinous ligaments. Butler (1954) described the abdominal removal of the deep pouch of Douglas, perineal rectosigmoidectomy, suture of the colon to the side wall of the pelvis and ventrofixation of the uterus. For some years the author has used the operation of anterior resection in the treatment of these cases and believes it has certain advantages.

Anterior resection for complete rectal prolapse

The essential steps of the operation are the same as when it is used for malignant disease The left iliac colon and sigmoid should be mobilized at the brim of the pelvis



FIG. 71.—The deep pouch of Douglas displayed at operation in the same patient The cervix can be identified below the retractor

so that the line of descent from the splenic flexure is almost straight. The fixity of the splenic flexure seldom varies and though the success of the operation does not depend on the security of the left phrenico-colic ligament, one of its objects is to excise sufficient of the rectum and sigmoid so that further prolapse is impossible. The peritoneal incision around the rectum in the pouch of Douglas should be wide; there will be no shortage of peritoneum here and the peritoneal floor and its deep prolongation down the posterior vaginal wall are to be excised (Fig. 72). The mobilization of the rectum must be quite complete and display the levator muscles on either side and the raphe posteriorly. Where there has been complete prolapse for some years



FIG 72 —Excision of the pouch of Douglas shown in Fig 71

the lower rectum is large and capacious, if it is not fully mobilized it will not have the opportunity to form fresh adhesions and the amount of rectum remaining below the site of resection is more difficult to assess. After mobilization a suitable point is selected for the division of the rectum and a clamp applied. The rectal stump remaining after the division should extend on the straight some 3 to 4 inches above the levator ani, somewhat longer than would remain after an operation for carcinoma

A Wertheim hysterectomy clamp is a convenient one when performing this operation for carcinoma but in prolapse the rectum is usually rather wide and a large right-angled clamp is preferable The clamp is applied at or about the level of the peritoneal reflection on the front of the rectum, the anterior rectal wall divided below it, picked up by a stay suture, the lumen of the rectum swabbed out and the division of the rectum completed. Vessels lying in the perirectal fat on the posterior wall of the rectum will almost certainly bleed. They should be picked up with long artery forceps, such as Roberts, and ligated with catgut. A suitable spot on the sigmoid colon is now selected which will excise all redundant bowel but avoid tension. A clamp is applied obliquely and the bowel divided above it. No clamp is used on the piece of bowel to be anastomosed. If the lumen of the bowel appears unduly small it

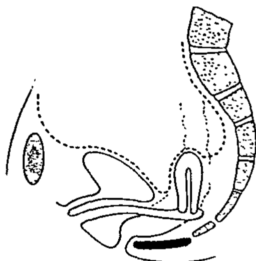


FIG. 73 —The position sought at the completion of the operation with the vagina and uterus fallen back on the right of the pelvis, the rectosigmoid anastomosis on the left and the peritoneal plane passing down over the front of the uterus and broad ligaments without a pouch of Douglas.

(Reproduced by courtesy of the Editor of Proc. R. Soc Med.)

may be slightly enlarged by a small incision along the antimesenteric border. Five or six interrupted mattress sutures of catgut are now inserted, but not tied, between the whole thickness of the posterior wall of the sigmoid, whose mesenteric border will lie on the right, and the whole thickness of the posterior wall of the rectal ampulla, where the needle should pick up the perirectal fat. The sutures are to apply the posterior walls in apposition and after they have all been inserted the sigmoid is slid down the sutures to the rectal stump and the sutures tied.

The anastomosis is now completed in the pelvis by a continuous catgut suture and outside this interrupted sutures of catgut or silk for the lateral and anterior parts of the anastomosis are inserted. When completed the anastomosis lies to the left of the mid-line, the sigmoid passing over the line of the left sacro-iliac joint to reach it. The deep peritoneal floor of the pouch of Douglas has been excised with the rectum. The peritoneum is now stripped up off the back of the broad ligaments and the side walls of the pelvis and resutured in such a way that at the completion the sigmoid will



FIG. 74 —Post-operative film in the knee-elbow position of a patient with complete rectal prolapse treated by anterior resection

(Reproduced by courtesy of the Editor of Proc. R Soc Med)

pass downwards in the left posterior quadrant and the uterus tubes and upper part of vagina will lie in the right posterior quadrant of the pelvis. The ideal is that no pouch of Douglas should remain and that the peritoneal plane of the posterior abdominal wall will pass into the pelvis over the front of the uterus (Fig 73). When the abdominal part of the operation has been completed a small incision is made near the coccyx and a corrugated rubber drain introduced so that it lies in the hollow of the sacrum, behind the anastomosis. It prevents the collection of blood and serum in the pre-sacral space and probably also increases adhesions in this region.

Post-operative care

Until normal peristalsis has returned and flatus has been passed, the patients are kept on intravenous fluids. The perineal drain is shortened and removed on the third and fourth days It is convenient to have continuous bladder drainage for the early post-operative days. Since the anal sphincter in these patients is stretched and somewhat atonic there is no necessity for the use of a flatus tube. When the patient has become mobile she is instructed in sphincter exercises and given faradic stimulation Once the constant stretching of the levator hiatus by the prolapse has been stopped the muscle has a chance to recover its tone and though many of these patients have some difficulty in controlling liquid faeces in the immediate post-operative period, it is remarkable how quickly the majority of them recover from this disability.

Advantages of the operation

The advantages that may be claimed for this operation are several; it performs a radical excision of the prolapse and since it does so from the abdomen it is possible to excise all redundant bowel. Adhesions form around the anastomosis, fixing it to



FIG 75 —Barium enema three years after the operation of anterior resection for complete rectal prolapse Note the straight line down from the splenic flexure

the sacrum and soft tissues of the pelvis. With the sigmoid on the left and the uterus and adnexa on the right there is a block over the very part of the pelvis that was previously so weak. The levator ani is given a chance to recover. Skiagrams taken of the rectosigmoid region at varying periods after the operation suggest that a recurrence of the complete rectal prolapse would be anatomically impossible (Figs. 74 and 75), though some mucosal prolapse has occasionally occurred after the operation of anterior resection performed for carcinoma. Finally, though it is a major abdominal operation it is one that has a remarkably low mortality and elderly patients, particularly women, seem to stand it well.

Criticisms of the operation

The criticisms against this operation are that it is a major operation for which few patients are unsuitable and that it excises part of the rectum. Patients suffering from complete rectal prolapse are seldom fully continent; patients with a normal sphincter upon whom an anterior resection is performed for carcinoma may experience some temporary difficulty in the control of their bowels, particularly if the remaining rectal stump is small. If an anterior resection is performed upon a patient already incontinent, there is the risk that while curing the prolapse the incontinence may be worsened. For this reason it is essential to leave an adequate rectal stump. Of the 10 patients upon whom the author has now used this operation for complete rectal prolapse several have had temporary difficulty but with one exception all have regained good continence. The one exception is a patient who still suffers from some incontinence 3 months after the operation. This patient also had complete uterine prolapse. Her levator hiatus was greatly stretched and though her rectal prolapse has been effectively cured her anterior and posterior vaginal walls still prolapse on straining. Further operative measures will be required. No patient has yet shown any recurrence of the rectal prolapse.

It is said that some patients with complete rectal prolapse are old, stout and of low mentality. No doubt this is true but apart from age it has not been the author's personal experience. Most of the author's patients have been bright-eyed old ladies in their seventies and eighties, whose active life of shopping and housekeeping has been ruined for them by the humiliating discomfort of a complete rectal prolapse. "I am now able to lead a normal life, doing my housekeeping and looking after an invalid sister. It is such a happy change for me . . ." wrote a lady of 79 years of age who had had the operation 2 years before.

CONCLUSION

It is justifiable to urge that some form of operative treatment should be adopted for complete rectal prolapse in all but the frailest patients and that whenever possible the operation should be by the abdominal route. It is worth a risk to restore these patients to their activities and the risk is a small one.

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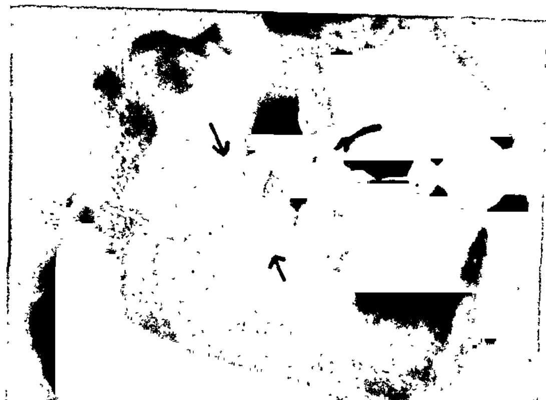


FIG 76 —Sialogram of parotid showing parotid abscess as result of subacute infective parotitis. The arrows indicate the abscess

used to occur in the late stages of chronic mental illness, but is now rare. It is still seen from time to time in institutions nursing patients in the late stages of malignant disease. Under these circumstances, it is often referred to as *acute cachectic parotitis*, and, apart from severe infective features, necrosis of the gland may result so that it is sometimes an *acute gangrenous parotitis*. The prognosis of these types of parotitis is very bad and the complication is often a terminal one.

In the aforementioned conditions the infections are the primary cause of the parotitis, that is to say, the infection develops in previously healthy glands If the patient recovers from the infection, whether with or without abscess formation, there is no special tendency for the condition to recur. Duct-borne infections may, however, occur as a secondary phenomenon in other varieties of parotitis, for example, secondary to calculus formation and in recurrent parotitis of obscure origin.

Tuberculous parotitis is rare, but not so rare that the possibility of its occurrence can be ignored. It seems to be commoner in France than in Great Britain, and Redon (1955) had 24 cases between 1940 and 1955. We have recently analysed the clinical and pathological features of 6 collected cases (Patey and Thackray, 1954).

Clinically, primary tuberculous disease of the parotid presents as a slowly growing lump in the parotid, which is usually diagnosed as a parotid tumour. The correct diagnosis is only made either if the lump caseates, which may be late, or on surgical exploration.

Pathologically, two types are found In the commoner, the disease affects the intraparotid lymph nodes which as a normal anatomical feature contain parotid tubules; less commonly, there is diffuse replacement of parotid gland lobules by tuberculous granulation tissue (Fig. 77). The tuberculous affection of the parotid is not necessarily or even usually accompanied by tuberculosis of the lymphatic glands of the neck or tuberculosis elsewhere, and this, together with the fact that it is the facial process of the parotid which is most often affected, raises the possibility of a local origin such as a duct or periductal lymphatic spread from the mouth. A relation



FIG 77 —Low power view of a parotid gland showing numerous foci of tuberculosis, some with central caseation, scattered throughout the lobules (× 52)

between tuberculosis of the parotid and the uveal tract used to be postulated (uveo-parotid syndrome), but it is now thought that most cases of this syndrome are examples of sarcoidosis.

Tuberculosis of the parotid is often treated by parotidectomy under the wrong diagnosis of parotid tumour, but such treatment is of value in any case since there may be multiple foci of tuberculosis in the gland.

PAROTITIS SECONDARY TO CALCULUS FORMATION

In contra-distinction to the submaxillary gland, calculi in the parotid gland are rare. An apparent exception to this is the fact that on careful microscopical examination of parotid glands removed surgically for parotitis of obscure origin, one not infrequently finds small calculi about one millimetre in diameter in the intra-lobular ducts They may also be seen on straight radiographs as small faint opaque spots. They are not usually associated with the obvious inflammatory areas, and we have therefore regarded them as incidental

The parotid calculi of clinical importance are usually situated in the main duct or one of its larger branches Their cause, as in the case of the commoner calculi in the submaxillary gland, is unknown The typical clinical picture is one of recurrent parotitis, only to be distinguished from other types of recurrent parotitis by the demonstration of the calculus. There may be the syndrome of increased swelling of the gland after meals as in the submaxillary, but in the parotid this is a much less marked feature. Sometimes the calculus can be seen at the duct orifice, or be felt on probing the duct. If there is secondary infection, the duct orifice may be oedematous and congested, and there may be an associated purulent discharge. The patient will sometimes note the passage of the calculus into the mouth with an associated sudden



FIG 78—Phleboliths in haemangioma of parotid, simulating calculi.



FIG 79—Same case as Fig 78 showing haemangioma after injection of diodone into vascular spaces

relief of symptoms. In spite of the fact that parotid calculi, like those of the submaxillary gland, are stated to be composed predominantly of calcium carbonate and phosphate, they may easily be missed on radiological examination, partly because the calculus is usually of small size, and partly because it may be obscured by the bony structures of the neighbourhood. For these reasons, Redon (1955) stresses that before a calculus of the parotid duct can be excluded, intra-oral films must be taken. We would also lay stress on the importance of tangential films designed to avoid the superposition of the calculus on the bone structures. We have had two cases in which the calculus was demonstrated as a negative shadow on sialography. The only condition which can reasonably be mistaken radiologically for a calculus is a calcified phlebolith in a haemangioma. A phlebolith is smooth, rounded, and sometimes laminated (Fig 78), and sialography shows that the shadow is outside the duct system. Redon has reported a similar case. In our case the diagnosis of haemangioma was completely established by Dr. J. N Pattinson by direct intravascular injection of diodone (Fig 79)

If the calculus passes spontaneously, no further treatment is necessary though further calculi may form If the calculus does not pass spontaneously, it may do so following dilatation of the duct by lachrymal probes or following enlargement of the duct orifice. Rarely, particularly in diffuse intra-glandular calculi, parotidectomy with preservation of the facial nerve may be indicated.

RECURRENT OR CHRONIC PAROTITIS OF OBSCURE ORIGIN

In contra-distinction to acute non-specific infective parotitis and parotitis secondary to calculus formation, which show no special tendency to recur, cases of parotitis



FIG 80—Bilateral slowly progressive swelling of parotid glands of many years development as manifestation of chronic parotitis.

of obscure origin are not infrequently seen, the main feature of which is their persistence or recurrence.

There are two main clinical pictures; the commoner is that of recurrent painful swelling of one or both parotid glands. The condition may start either in childhood (Pearson, 1935; Jones, 1953) or in adult life. Women appear to be more commonly affected than men (Payne, 1933). Suddenly, without obvious reason, the parotid gland becomes diffusely and often markedly swollen, the swelling usually showing no variation in size with meals. There may be fever at first, but this does not usually last for more than a day or so. The swelling persists with diminishing pain, and in bad attacks may not completely subside for a week or two. If the condition manifests itself in both glands, it does not usually do so simultaneously, and is often more marked on one side. The initial attack having subsided, further attacks may not occur for months or years, but on the other hand they may occur so frequently that in the case of children the amount of time lost from school may become a problem.

Apart from the swollen gland, there are no other abnormal physical signs, and in between attacks there is nothing abnormal to be seen clinically.

The second and less common clinical picture is of gradual painless enlargement and induration of one or both parotid glands (Fig. 80). Usually the swelling involves the whole gland. Occasionally, it may be confined to a part of one gland, in which case the differentiation from a tumour of the gland may be difficult or impossible without surgical exploration. There may be a combination of these clinical pictures. Thus, there may be recurrent painful swelling of one gland, and a progressively enlarging painless swelling of the other, or the condition may start with recurrent swelling and later continue as a gradually enlarging, tumour-simulating swelling of the same gland.

In the earlier stages, there is no obvious bacterial infection, and the duct orifice is normal. After the condition has persisted for some time, particularly in the type



Fig. 81.—Sialogram of parotid to show *main duct dilatation.*

with recurrent swelling, infection with mouth organisms may become superimposed, and there is then the added picture of an acute or subacute infective parotitis with an inflamed oedematous duct orifice from which pus may be expressed. Under these circumstances, abscess formation may also occur.

Radiological appearances

Sialography after injection of Lipiodol into the duct may give valuable information in these cases of recurrent parotitis. It has recently been shown, however (Thackray, 1955; Patey and Thackray, 1955), that interstitial extravasation is easily produced in the parotid, particularly in this condition, so that the test should be used with caution. Small quantities should be injected, in the first instance starting with 0·5 millilitre or less, and even such a small amount may fill the duct system. It is unwise, too, to rely on the criterion frequently adopted of waiting for the patient to complain of



Fig 82.—Sialogram of parotid of child aged 6 to show so-called "sialectasis" Only 0·3 millilitre of opaque medium was used in this case

discomfort before stopping the injection since marked extravasation may occur before this stage is reached.

Two main types of radiological picture are obtained: (1) main duct dilatation (Fig. 81), and (2) glandular "sialectasis" (Fig. 82).

The differentiation between the two is usually easy. The dilatation of the main duct in the first type does not extend beyond the primary divisions of the principal duct, and the intra-lobular ducts are normal. If more dye is injected, the pattern of the glandular acini shows up as a diffuse cloudy opacity. Occasionally, there may be a combination of both types of radiological picture, that is, dilatation of the main ducts associated with glandular "sialectasis", but any marked degree of both in combination is uncommon.

The glandular "sialectatic" picture is well known under a multiplicity of names, for example, "globular sialectasis", "bronchiectatic type sialectasis", and the "image en grains de plomb" of the French. Until recently it was regarded, as the term

"sialectasis" implies, as resulting from dilatation of the small intra-glandular ducts. Recent work, however (Thackray, 1955; Patey and Thackray, 1955), in which the radiological and histological pictures of *parotidectomy* specimens from cases of chronic parotitis were carefully compared, has shown *that* such is only partially the case, and that the globular areas represent for the most part areas in which the dye has



FIG. 83.—Sialogram to show main duct dilatation associated with intra-glandular filling defect (indicated by arrows) due to lymphoid hyperplasia

extravasated interstitially through weakened duct walls. It is this finding which renders caution in the amount of the dye injected particularly necessary in these cases. The question will be further discussed under pathological anatomy. The extravasated dye may persist in the gland for weeks, months, or even years, particularly if large amounts are used, another reason for using the minimum amount that will give a diagnostic picture. The characteristic "sialectatic" picture may be present on both sides with symptoms confined to one side, or confined to the side of the symptoms.

Another occasional sialographic finding is a filling defect in the gland. This is much more common with the "sialectatic" picture but may also occur with main duct dilatation (Fig. 83). It occurs in the later stages of the disease, and is due to replacement of the gland lobules by lymphoid tissue. In the later stages, too, the number and complexity of the intra-glandular duct systems may be reduced, partly from the lymphoid hyperplasia, and partly from blocking of the ducts through the epithelial [illegible] under pathological anatomy.

[illegible] ings, it should be pointed out that the two main clinical pictures of chronic parotitis already described—recurrent painful

swelling of the gland, and a progressively enlarging tumour-simulating condi
may each be associated with either of the radiological pictures—main duct dila
or glandular "sialectasis", but if there is marked, persistent, and progressive en
ment of the gland, the "sialectatic" picture is much the more common.

Pathological anatomy

The pathological findings in glands removed for chronic or recurrent parotiti
considerably, but two main types of histological picture can be recognized.
first, which approximately corresponds to the radiological type with main
dilatation, the dilated main duct can be seen surrounded by a dense fibrous
The lobular pattern of the gland is still recognizable with the low power
microscope, but there is an increase in the interlobular fibrous tissue. The
intra-lobular ducts are also surrounded by hyaline fibrous tissue, but most
smaller ducts have disappeared. There is marked atrophy of the acini with ly
cytic infiltration (Figs 84 and 85). This is a similar picture to that met with in
obstruction of the main duct by a calculus.



FIG 84—The main duct of the parotid grossly dilated with dense fibrous tissue surrounding it and separating the lobules of the gland (× 21).

Two types of histological picture are seen in association with the "sialec
type of parotitis, which appear to be stages in the development of the same
In the early stages, there may be little or no naked eye abnormality. Microscopi
the main duct and its interlobular branches are normal, apart from a little lyn
cytic infiltration of the periductal supporting fibrous tissue. The typical chang
found in and around the large intralobular ducts. At first, there is marked peri
lymphocytic infiltration, with fragmentation and disappearance of the conn
tissue fibres of the duct wall. As the attacks recur the zone of inflammatory infilt
becomes more marked, and germinal centres appear in the accumulated ma
lymphocytes. The lumen of the affected duct may show some dilatation fro
loss of its supporting fibrous tissue, but often there is proliferation of the
epithelial cells, which together with the pressure of the mass of lymphoid tissu
narrow and eventually block the lumen. Occasionally, when secondary infectio
supervened, the ducts are full of pus cells. The acini corresponding to the af

intralobular ducts show varying degrees of atrophy. At this stage, *the lesion* is a patchy one, affected and normal lobules occurring side by side (Fig. 86)

In the later stages, most of the lobules in the gland may be replaced by lymphoid tissue (Fig. 87), in which lie solid branching columns of epithelial cells representing all that remains of the duct system (Fig. 88). The picture thus shows comparable features to that of chronic lymphadenoid thyroiditis. Even in these advanced cases, the interlobular fibrous tissue *with the associated main* ducts may be relatively



Fig. 85.—Atrophy of the secreting acini of the parotid gland, and replacement by fibrous tissue infiltrated with lymphocytes Fibrosis around the larger ducts and between the lobules. From the same case as Fig. 84 (× 21)

unaffected. Occasionally, however, there may be some periductal and interlobular [illegible] latation. The naked-eye appearance of glands [illegible] Whereas the normal parotid is composed of [illegible] brown colour with loose interlobular connective tissue, in this condition the lobules are swollen and rounded, soft and white. Glands with this advanced condition of the lesion show focal or general swelling from the excess of lymphoid tissue present, and a mistaken diagnosis of tumour may be made either clinically or because a filling defect is present on radiological examination. Histologically, too, a mistaken diagnosis of tumour may be made, particularly if only small portions of tissue are available for examination, lympho-epithelioma being simulated.

Apart from the pathological changes due to the lesions themselves, other changes may result as a response to the sialographic examination. Serial section studies correlated with radiography of surgically removed glands (Thackray, 1955; Patey and Thackray, 1955) have shown that the "sialectatic" picture radiologically is due essentially to escape of globules of the oily contrast medium interstitially through ruptures of the degenerated intralobular duct walls. These escaped globules in the course of time are surrounded by histiocytes and foreign body giant cells (Fig. 89), and excite a marked fibrous reaction. Some of the radio-opaque medium is carried off to the intraparotid lymph nodes, where it can be recognized in the peripheral sinuses (Fig. 90) The existence of this artificially produced chronic parotitis emphasizes



FIG 86 —Chronic "sialectatic" parotitis, showing some comparatively normal lobules and others with considerable amounts of lymphoid tissue around the intralobular ducts Areas of extravasation of oily contrast medium marked X Main duct at centre relatively unaffected (× 21)



FIG 87 —Advanced case of chronic parotitis showing lobules of the parotid gland enlarged and almost replaced by an accumulation of lymphoid tissue in which solid columns of epithelial cells are recognizable Interlobular connective tissue relatively unchanged (× 21)



FIG 88 —High power view of part of Fig 87 to show the islands of epithelial cells in the background of lymphoid tissue (× 75).

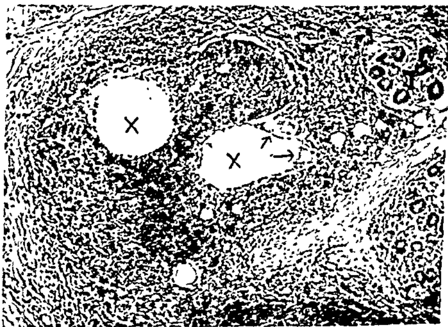


FIG 89 —*Two areas of extravasation (indicated by Xs) in a chronically inflamed parotid gland following previous sialography*. The globules are surrounded by histiocytes and foreign body giant cells, two of which are indicated by arrows (× 110)

the importance of care in performing the diagnostic test of sialography and in particular of using the minimal amount of injection medium.



FIG 90—Oily globules with foreign body giant cells (indicated by arrows). The globules are in the peripheral sinus of an intraparotid lymph node From a case of chronic "sialectatic" parotitis in which sialography had been performed (× 110)

Differential diagnosis

In the early stages, as already noted, a diagnosis of mumps is frequently made, particularly in children In cases with a history of recurrent swelling, the diagnosis is easy and is confirmed by the sialographs In cases in which the condition presents as a gradually enlarging swelling of the parotid, particularly if unilateral and localized, the differential diagnosis from tumour may be difficult or impossible clinically Even the demonstration of a characteristic radiological picture does not exclude tumour, as a combination of tumour and chronic parotitis may co-exist Apart from tumour, diffuse parotitis may be simulated by parotid hypertrophy, and by hypertrophy of the masseter muscle In the former, the "parotidomegalie essentielle" of Redon, both parotid glands, though large to the point of cosmetic disability, may be quite normal both to sialography and even on biopsy. Idiopathic hypertrophy of the masseter (Fig. 91), which may be unilateral or bilateral, should not in theory be mistaken for a parotid swelling but sometimes is, even to the point of surgical exploration.

Aetiology

As already indicated in our classification, the cause of the conditions which have been discussed is obscure and as a rule largely a matter of speculation, but, as has been seen, two fairly clearly defined types can be recognized, one of which has as its characteristic feature dilatation of the main ducts with periductal fibrosis and lobular fibrosis and atrophy, the other of which shows no marked dilatation of the main ducts nor periductal fibrosis, but the most striking feature of which is lymphocytic accumulation around and fragmentation of the intralobular ducts. Though in the later stages the microscopical findings tend to approximate, it would appear most



FIG 91 – Case of hypertrophy of left masseter muscle simulating chronic parotitis

likely that in the beginning we are dealing with two separate conditions wit
aetiologies. With regard to the main duct dilatations, the radiological a
logical appearances described here are those met with when the parotid
removed for a definite obstructive lesion such as a calculus. Thus, the
which Figs. 84 and 85 were taken had a history of the passage of calculus s
previously, and clinical evidence of fibrous obstruction of the duct orifi
cases with similar radiological and pathological findings without a calculus
reasonable, therefore, to postulate some latent obstructive cause. Many su
have been made—oedema or fibrosis of the duct papilla from trauma or
from the teeth (Rose, 1954), a plug of mucus secreted by the mucous gla
the main duct (Payne, 1933), or a fibrinous plug from allergy. Gross dilatat
main parotid ducts may be demonstrated in control post-mortem subjects
history of salivary gland disorder, thus raising the possibility of an achalas
obstruction. Under these circumstances, the onset of symptoms might b
infection in the relatively stagnant contents of the dilated duct. In favo
obstructive aetiology is the occasional clearing up of the condition f
dilatation or enlargement of the duct orifice. Tentatively, therefore, even wh

If the aetiology is often not clear in the above group, it is still less clear in the "sialectatic" group, and the problem has to be posed and studied afresh in light of the knowledge that the essential lesion is not a true sialectasis of the gland comparable to bronchiectasis, but primarily a weakening of the intralobular duct walls associated with lymphocytic infiltration. Thus, the theory that the condition is congenital (Bailey, 1945) in the sense that an individual is born with a honeycomb-like gland, is no longer a correct posing of the problem There may be a congenital factor, but if so it must be something more subtle such as some pre-disposition to the lesion. Such a pre-disposition might depend on local or general factors.

Of local factors, the most striking is the limitation of the "sialectatic" picture to the parotid glands, the condition not having been described in the submaxillary glands, and in confirmation of this, while the radiological picture of "sialectasis"—though with differences from that seen clinically—is easy to produce in post-mortem subjects in the parotid, it cannot be produced in the submaxillary (Ranger, 1956) In other words, the "sialectatic" picture is an incidental artefact, but one peculiar to the parotid, and more easily produced in certain types of chronic parotitis than in the normal gland.

In further search of possible local factors, one of us (A.C.T.) has been studying the detailed structure of normal and pathological parotid glands by serial microscopical sections. Contrary to what is usually taught, some parotid glands in addition to the well recognized mucous cells at the duct orifice do contain numerous mucous and even sebaceous glands (Fig. 92), sometimes in large numbers. The presence of sebaceous material in the secretion of the gland might have abnormal mechanical influences, and an endeavour is being made to see whether there is any correlation between the presence of such glands and the development of the "sialectatic" lesion. The study, which is obviously a laborious one, is as yet not sufficiently complete for conclusions.

The other more obvious local factors that have often been suggested as causative in the "sialectatic" type of parotitis are infection and obstruction, but infection is



FIG 92.—A sebaceous gland liberating its cells into an intralobular duct in the parotid. This was one of many hundreds present in the gland removed from a recent case of recurrent parotitis (× 275)

clinically late, and the cases of undoubted primary infective parotitis such as after operation show different radiological and pathological features, and also no special tendency to persist or recur. It seems more likely, therefore, that infection in these cases of chronic parotitis is a secondary phenomenon. The existence of the lesion radiologically before any symptoms is also a point against a primary infective cause. Against a primary obstructive cause is our ignorance of such a cause, and the fact that the pathological picture in undoubted obstructive conditions is quite different. If there is obstruction it is due to something not so far demonstrated, and at the intralobular duct level.

Suggestions have been made that alterations in the constitution of the saliva may be a responsible factor, and as evidence is adduced the fact that the secretion coming from an affected parotid duct may appear more viscid than normal. Investigations carried out on a small number of our cases (Kirk and Pawan) have, however, failed to demonstrate any consistent change in either the viscosity or the protein content of the saliva from the affected glands. The occasional increased viscidity of the initial salivary secretion, which we too have noted is, therefore, presumably due to inflammation of the terminal parotid duct with its well recognized contained mucous cells. Such a condition might cause obstruction and dilatation of the main ducts, but could not reasonably explain the "sialectatic" picture.

Of general factors which might be responsible, allergy has frequently been suggested (Meyer, 1934; Munro, 1951; Smith, 1953). There has, however, been little attempt to work out the nature of the postulated allergic reaction nor its mode of action. Occasionally a typical parotitis may be present with associated trouble in the other salivary glands, the lachrymal glands, or elsewhere.

It will be convenient to mention in conclusion two eponymous conditions—Mikulicz disease and Gougerot-Sjögren's disease. Mikulicz (1892), under the title of *A peculiar symmetrical disease of the lachrymal and salivary glands*, reported the case of an East German peasant aged 42 years with a history of swelling of lachrymal, parotid, sublingual and submaxillary glands of both sides for 7 months. He removed the lachrymal and submaxillary glands, which microscopically showed replacement of the epithelial elements by masses of small round cells with occasional mitoses. Three months later, the patient died in his own village of a reputed "perityphlitis"; there was no post-mortem examination. No material for histological examination was ever taken from the parotid glands, and there is in fact no proof that the swelling of these glands was due to involvement of the salivary tissue rather than of the intraparotid lymph nodes. Mikulicz discussed at considerable length the possible [illegible] inflammation, which he finally [illegible] term "Mikulicz [illegible] obscure origin of [illegible] dumping ground [illegible] h it is impossible to define accurately, has probably had a sterilizing influence on salivary gland pathology, and there is an increasingly widespread feeling that it should now be abandoned.

The Gougerot-Sjögren concept is more recent. In 1925, Gougerot, a French [illegible] of a progressive atrophy and [illegible] nds, and sometimes also of the glands of other regions such as the nose, larynx, and vulva. The condition did not excite much interest until 1932 when Sjögren, a Swedish ophthalmologist, described with full pathological and clinical details a similar general syndrome in which, in addition to the dryness of the eyes, rheumatic symptoms in joints, dryness of the mouth with a tendency to swelling of the parotids, and a diminution of perspiration were prominent features. The condition is therefore generally referred to as Sjögren's

disease, though in France it is known as Gougerot-Sjögren's disease. The histological picture in some cases of the syndrome (Sjögren, 1933; Morgan and Raven, 1952) does appear to resemble that found in our cases of "sialectatic" parotitis with the marked lymphocytic and lymph follicular accumulations, but in other cases (Ellman, Parkes Weber and Goodier, 1951) the picture appears to be one of simple atrophy with fibrous and fatty replacement. While, therefore, the concept of Gougerot-Sjögren's disease is valuable in drawing attention to the importance of general factors in recurrent parotitis, it is probable that the syndrome covers a number of different conditions, and care should be exercised that it is not allowed to degenerate into the diagnostic dumping ground for obscure parotid conditions that Mikulicz disease has become.

Treatment

The treatment of these obscure forms of parotitis must from the very fact of their obscurity be difficult and often unsatisfactory. It may be considered under the following (1) expectant; (2) minor duct orifice surgery, (3) irradiation; and (4) parotidectomy.

Expectant

Many cases of chronic or recurrent parotitis may give rise to so little in the way of symptoms, or at such long intervals, that the best course is to do nothing active except to relieve symptoms as they occur. In such cases, it is particularly important not to make the condition worse by excessive injection of the contrast medium when sialography is carried out, which as already mentioned may produce "chronic sialographic parotitis" from the physical and chemical trauma.

Minor duct orifice surgery

In the cases with main duct dilatation, it may be worth trying, particularly if there is evidence of stenosis, dilatation of the duct orifice by the passage of lachrymal probes, or enlargement of the orifice by slitting it up, with suture of the duct wall to the cheek mucosa But in cases without changes in the main duct, as in most cases of glandular "sialectasis", such procedures can obviously be of no benefit and may even be harmful by inducing stenosis or predisposing to infection. It should be noted that the operation of enlargement of the duct orifice, while in theory simple, is in practice often technically unsatisfactory and not infrequently followed by stenosis

Irradiation

This may occasionally be helpful particularly in cases of glandular "sialectasis" associated with pseudo-tumour formation. High doses are usually necessary and the resulting dryness of the mouth may be temporarily very uncomfortable (Gerry and Seigman, 1955). Irradiation is undesirable when marked secondary infection is present, and also in young children owing to the danger of interfering with the growth of the jaws

Conservative parotidectomy

The development and standardization of the modern operation of parotidectomy with preservation of the facial nerve provides a technical answer to the case which is unsuitable for or fails to respond to other measures. It should obviously not be lightly advised because of the potential danger to the facial nerve. When carried out with patience and care serious permanent danger to the nerve is rare and the results are most gratifying. In practice, the operation tends to be reserved for cases in which the possibility of tumour cannot be excluded, for children in whom the frequency and severity of the attacks are interfering with schooling, and for adults in whom the attacks are seriously interfering with their work.

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Period of suppression of function

During the period of suppression of function from injury of either cord or roots it is impossible to discover the extent of anatomical damage, and so long as this condition persists in complete form there must be uncertainty as to the possibility of any recovery of function.

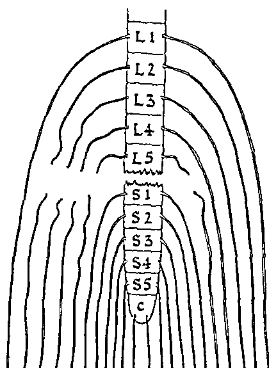


FIG. 93.—Diagram illustrating a mixed cord and root lesion *Clinical* examination of this patient would reveal paralysis and anaesthesia from the second lumbar segment on one side and from the fifth lumbar segment on the other. These clinical findings might erroneously be interpreted as a partial cord lesion at the second lumbar segment.

It is for this reason that there is so much controversy about the initial treatment of the injury. If the cord is anatomically divided no form of treatment can alter the prognosis. If the cord and roots are anatomically intact, recovery will occur without treatment, and all that is necessary is to protect them from further damage. If, however, there is a partial lesion then the need to protect the intact fibres from further damage is essential. In a root lesion, even if there is anatomical division of the axons, recovery is theoretically possible. Thus, in planning rational treatment, any guide to the true nature of the cord and root lesion must be of great importance.

DIAGNOSIS

The first essential in the diagnosis of the nerve lesion is to distinguish the paralysis and anaesthesia due to the cord lesion from that due to lesions of the nerve roots, for the latter may recover even if divided so that the prognosis of root injury is always better than that of cord injury. Moreover, unless the distinction is made, a mixed complete cord and root lesion, especially if an unequal number of roots is divided on each side, is frequently mistaken for a partial cord lesion at a higher neurological level, leading to a totally erroneous prognosis (Fig. 93).

Distinction between cord and root lesion

Accurate distinction between cord and root lesion depends upon a knowledge of the anatomical relationship between the spinal cord and the vertebral column (Fig. 94) and upon the fact that the nervous lesion can, with very few exceptions, be shown to be at the level of the vertebral injury (Holdsworth, 1954).

From Fig. 94 it will be seen that the cord ends at the lower border of the first lumbar vertebra Below this level the spinal canal contains the nerves of the cauda equina, and injuries below the first lumbar vertebra will therefore result in root lesions only.

Above the ninth dorsal vertebra the cord segments are roughly opposite the corresponding vertebra and injuries above this level can therefore be considered as pure

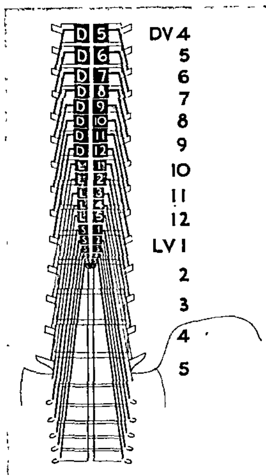


FIG 94—Diagram illustrating the re-

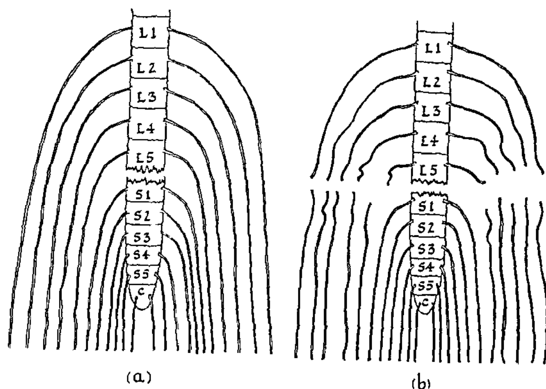
vertebrae

cord lesions. Between the ninth dorsal and the first lumbar vertebrae, however, lie all the lumbar and sacral neurological segments, and all the lumbar nerve roots. Injury at this level, for example between the twelfth dorsal and first lumbar vertebrae will divide the cord at the first sacral segment, and all the lumbar nerve roots, thus producing a clinical paraplegia as high as the first lumbar segment of which only the sacral paralysis and anaesthesia is due to cord injury, the rest is due to damage to the roots Various patterns of root and cord injury can occur as illustrated in Fig 95, each producing a different neurological pattern *with the same cord lesion.*

The injury illustrated in Fig 93 is especially liable to be erroneously interpreted on clinical examination as a partial cord injury at the L.2 neurological segment. Thus, careful neurological and radiological examinations should be made to determine the level of the cord lesion. If this is carried out it will be impossible to confuse root escape with partial cord injury, for only the presence of sensation or motor power, or both, in the segments below the cord level can indicate a partial lesion.

Total temporary suppression of function (spinal shock)

The temporary complete suppression of function below the level of a cord injury makes diagnosis of the exact nature of the cord lesion difficult. The difficulties,



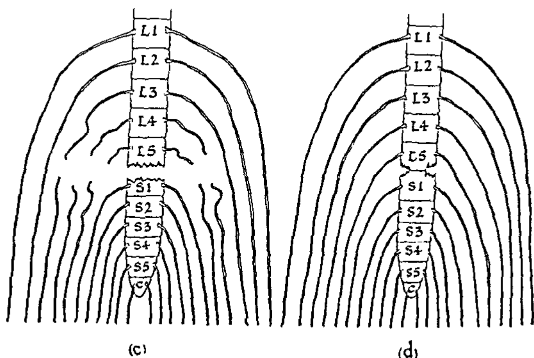


FIG. 95.—Patterns of root and cord injury (*a*) Complete cord division with complete root escape; (*b*) complete cord and root division, (*c*) complete cord division with partial root escape, (*d*) partial cord division with complete root escape

below the cord injury, an accurate diagnosis can be made within 8 hours

Stability of the spine

In the dorsal and lumbar regions stability of the spine after fracture or dislocation depends upon the damage sustained by the posterior ligam articular facets and not upon the damage to the vertebral body. If the

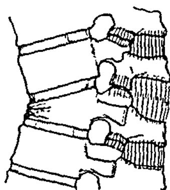
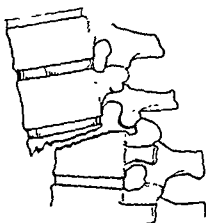


FIG. 96.—Stable crush fracture of the vertebral body. The posterior ligaments are intact.



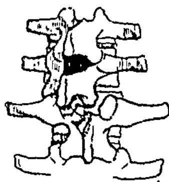


FIG. 97—Rotational fracture-dislocation of the spine. The "slice" fracture of the lower vertebra and the lateral displacement of the spinous process and articular processes are characteristic.

ligaments remain intact then the vertebral body is crushed and the fracture is im and stable (Fig. 96). Further displacement will not occur unless the spine is sub to violence in excess of that which originally produced the fracture. Such fractures are only rarely associated with paraplegia. The distortion of the ver canal is not great and therefore reduction of the deformity followed by splint unnecessary.

Fracture-dislocation of the spine associated with rupture of the posterior liga and fracture of one or both articular processes is usually the result of severe tor violence. A rotational fracture-dislocation results which is extremely unstable. is the type of fracture-dislocation commonly associated with paraplegia (Fig. 9 can be recognized by clinical examination and by the typical radiological appear On palpation of the back a gap can be felt between the spinous process of the in vertebrae due to rupture of the supraspinal and intraspinal ligaments. The r graphs show a lateral shift of the articular processes and spinous processes an



(a)



(b)

FIG 98.—Skiagrams of a typical (a) and (b) rotational fracture-dislocation. The "slice" fracture and lateral displacement of the spinous and articular processes are well illustrated.

extreme instability of this injury [illegible]
original displacement is reduced [illegible]
films are exposed with the patient in this position, or in the lateral position with the shoulders and the pelvis held in line, *the displacement* shown may be very slight. With this type of fracture-dislocation the *slightest torsional strain* on the spine will reproduce severe displacement. Such fracture-dislocations must be supported during the time necessary for repair to occur.

In [illegible]

Ru [illegible]
the lo[illegible] interlocked facets. In such injuries *the intervertebral disc is often* protruded causing additional damage to the cord (Fig. 99). Dislocations of this type are best reduced by skull traction, using the Blackburn type of skull caliper. *After reduction* the spine remains unstable and re-dislocation may occur. *It is therefore* advisable that the spine should be held by internal fixation either by a bone graft or by wiring the spinous processes together.

Extension violence, especially in the elderly, may cause rupture of the anterior longitudinal ligament with hyperextension of the upper vertebra upon the lower. Such injuries cause cord damage by compression by the unfolding of the ligamentum flavum *(Fig. 100). Such dislocations* are stable, however, provided the head is held in flexion by means of a collar.

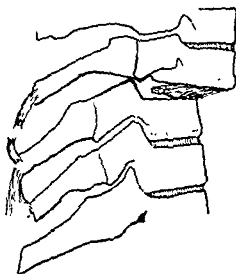


FIG. 99.—Dislocation of the cervical spine. The posterior ligaments are ruptured.

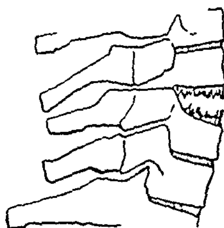


FIG. 100.—Extension injury to the cervical spine. The anterior common ligament is ruptured and the spine angled backwards.

TREATMENT

Careful neurological and radiological *examinations will enable the following facts to* be elicited 6–8 hours after injury: (1) the amount *of cord and root damage*; and (2) whether or not the cord is *anatomically divided*.

Palpation of the back and radiological examination will also reveal whether the bone injury is stable or unstable. *With these facts in mind immediate treatment can* be decided upon a rational basis.

Anatomical division of the cord

Cervical and upper dorsal regions

In the cervical region and in the region above the ninth dorsal vertebra the root injury is unimportant for the neurological segments are almost opposite the corresponding vertebrae (Fig. 101). Thus, if the cord is divided recovery cannot be expected and the object of treatment of the vertebral injury is simply to prevent deformity.

At these high levels deformity is not very important, for it is unlikely that caliper walking will ever be of real use to the patient. Thus, in the dorsal region careful

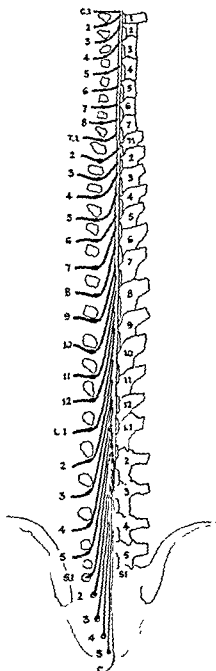


FIG 101.—Diagram of the vertebral column, the cord and the roots to show the relationship of the cord segments to the vertebrae.

nursing is all that is necessary, but in the cervical region the special difficulties of nursing may make it advisable that the spine should be fixed by internal fixation.

Dorso-lumbar region

It is in the dorso-lumbar region that mixed cord and root lesions occur and since, as previously stated, the cord is more vulnerable to injury than the roots, escape of roots in the presence of complete cord division is not infrequent Even if the roots appear divided on early examination, they may recover function weeks after the injury.

In fracture-dislocation of the dorso-lumbar junction all the lumbar roots may be involved. These roots control hip flexion and knee extension and the sensation of almost the whole leg (Fig. 102); their escape or recovery is therefore of the greatest functional importance. A patient with a lumbo-dorsal fracture-dislocation, transection of the cord at the S.1 segment and complete root escape will be able to walk with short calipers, whereas a similar cord injury with complete root division will have flail legs necessitating full-length calipers and crutch swinging (Fig. 103).

Thus, in lumbo-dorsal injuries resulting from unstable fracture-dislocation, the roots must be protected and the spine splinted so as not to impede their possible recovery. With stable fractures, of course, such splinting is unnecessary.

Lumbar region

The cord ends at the lower border of the first lumbar vertebra; therefore injuries below this level result in pure root lesions. Recovery is always possible in such lesions, and as with unstable fracture-dislocations the spine must be supported.

Partial cord lesions

With partial lesions of the cord, the result of unstable fracture-dislocations at any level, the spine must be stabilized to prevent further cord damage. If the partial cord lesion is the result of a stable fracture then, clearly, support to the spine is unnecessary.

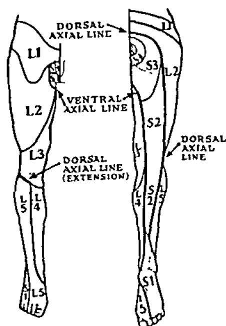
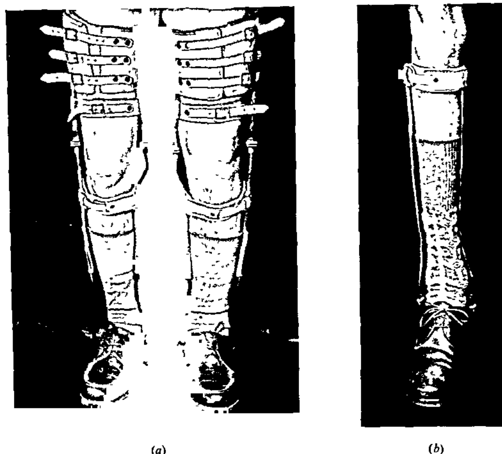


FIG 102.—Segmental sensory innervation of the leg, together with a diagram indicating the functions of the lumbar roots



(a) (b)

FIG 103 —Two patients with cord division at the S 1 segment One patient (a) also has complete lumbar root division and requires long calipers, the other (b) has complete lumbar root escape and requires only short calipers, as his hips and knees are stable

Methods of stabilization of the spine

Fractures and fracture-dislocations associated with cord and nerve-root damage can be divided into stable and unstable types If the vertebral injury is unstable then some form of splinting is desirable during treatment to prevent movement occurring at the site of injury. Prevention of movement at the fracture site is important for two reasons First, because movement might cause further damage to a partial cord or root lesion and might obstruct recovery in damaged roots. Secondly, to prevent permanent deformity of the vertebral column, for marked angulation of the spine adds to the difficulties of rehabilitation.

After unstable fracture-dislocation the vertebral column may be held firm during the period of healing, either by external splinting or by internal fixation Two methods of external splinting are available: (1) plaster applied as a jacket or a plaster bed with turning case; and (2) a Styker frame.

Plaster jackets and plaster beds

The results of nursing paraplegic patients in plaster beds are disastrous (Fig 104). The anaesthetic skin is peculiarly vulnerable to pressure, and large sores can be produced in a matter of hours unless the pressure areas are changed with great frequency. This is impossible with plaster beds or jackets and large sores usually result. In a series of 16 patients nursed in plaster beds every patient developed one or

more intractable bedsores (Holdsworth and Hardy, 1953) The method is mentioned only to be thoroughly condemned.

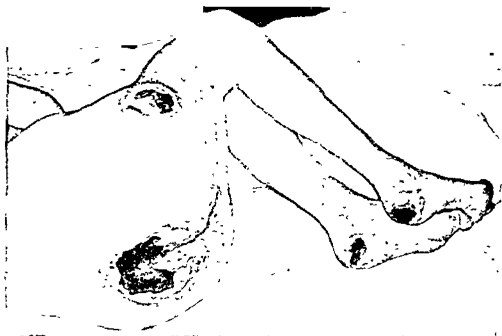


FIG 104 —Plaster sores, the result of nursing in a plaster bed.
(By courtesy of the Editor of J Bone Jt Surg)

Styker frame

The Styker frame is a mechanical rotating bed on which the position of the patient can be changed frequently so as to prevent sores. The method is sound but requires expert attention and is expensive. It is, however, comparatively safe, for turning can be carried out with the shoulders and pelvis held in alignment. Complete immobility of the fragments is, however, difficult to obtain, and, of course, in fracture-dislocations reduction of the deformity must be carried out first.

Operative reduction and internal fixation

Open reduction and fixation of the spine by metal plates bolted to the spinous processes has many advantages (Fig 105). Such internal fixation, if properly performed, results in excellent stability and the patient can be nursed in an ordinary bed and regularly turned to prevent bedsores with no fear that further displacement of the vertebrae will result in damage to the contents of the spinal canal. In fracture-dislocations with gross displacement the method follows upon reduction, which is the method of re-alignment least likely to cause further injury to the cord and roots.

Technique

A midline incision is made sufficiently large to expose at least four spinous processes [illegible] supraspinal [illegible] or spinal [illegible] chisel or wide periosteal elevator the mass of the erector spinae muscles is cleared from the spine and laminae laterally to expose the lateral articulations. The dislocation is then clearly visible and the extent of damage to the articular processes easily seen. The spinous process of the vertebra above and that below are seized with powerful bone-

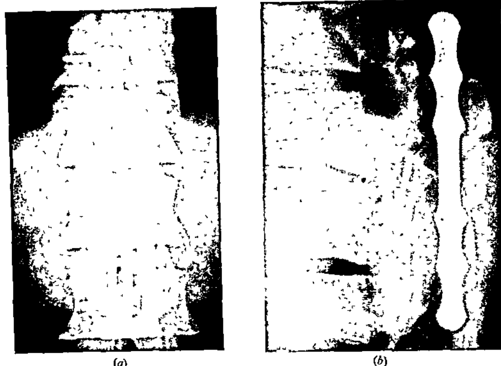


FIG 105—Skiagrams of a fracture-dislocation of the spine fixed by plates bolted to the spinous processes (a) and (b)

reduction

At least four—better five—spinous processes are then drilled with an angled awl; three above and two below the dislocation Fixation of at least four vertebrae is necessary for the dislocation is a rotational displacement and plating of only two or three vertebrae will still allow lateral rock of the upper upon the lower vertebra (Fig. 106) The holes should be drilled in the centre of the spinous processes

advocated by Williams are most suitable. The muscles and skin are then sutured back into place

If properly applied to the spinous processes the affected part of the spine will be held rigid for 12–15 weeks, and by this time anterior fusion of the affected bodies is sufficiently advanced to hold the dislocation. The loosening of the plates which may occur after this time is therefore unimportant.

Except in the cervical region fixation should be by plates and not by bone grafts; the latter frequently break under the torsional strains which may result from turning. Moreover, since, as already stated, artificial fixation is for only 12–15 weeks, a graft is therefore unnecessary.

Complications

Although the operation is usually simple, difficulties can arise. Interlocking of the *articular processes may result in difficulty in reduction. The locking can be overcome* by increasing the deformity with the spinous processes held firmly in bone-holding

forceps and by angling the spine forwards. It is important not to remove intact articular processes for this adds to the instability after reduction and increases the strain on the plates.

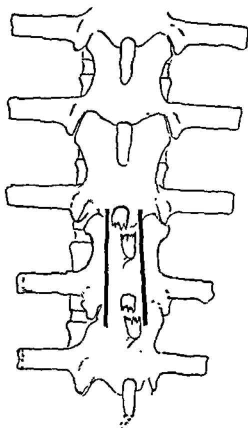


FIG. 106—If only two spinous processes are fixed by the plates the fracture cannot be controlled Rock can occur, the spinous processes will give way, and the plates will rapidly work loose.

One or more spinous process may be fractured. If one or two are fractured the difficulty can be overcome by extending the plates to the two sound spinous processes above and below. If, however, more than two are fractured it is probably better to abandon internal fixation and to rely on the Styker frame, or upon expert nursing with the greatest care in turning

It should be unnecessary to state that the operation must be performed properly and with care. It is useless to use one short plate fixing only two vertebrae, to plate the wrong vertebrae or to use screws instead of bolts. Under these circumstances failure is inevitable, and serious harm may result. Bad technique combined with complete lack of understanding of the principles of and indications for the operation are no criticism of the method.

Nursing

In the past most paraplegic patients died within 12–18 months. Death was most frequently due to chronic suppuration in huge bedsores together with urinary infection leading to renal failure.

Bedsores are the result of continuous pressure on the anaesthetic skin, and such pressure for only 6–8 hours will result in a large bedsore, the full extent of which may not become evident for 2–3 weeks. Thus, in the paraplegic patient, unless the skin areas taking pressure are frequently changed sores will inevitably result. *For this reason plaster or any other form of splint must never be used.*

The method of nursing on pillows with regular turning every two hours, day and night, as advocated by Guttmann is the most certain way of preserving an intact skin. The patient is supported on pillows (Fig 107) so that the trochanters, the sacrum, the ankles and the heels are free from pressure. Every two hours he is turned from the left side to the back, from the back to the right side and so on, day and night. After



FIG 107 —Nursing position Splints or plaster are not used at any time

6–8 weeks the skin acquires some tolerance to pressure, and moreover, the patient learns to turn himself with assistance, but throughout his life he is always liable to sores, the result of continuous pressure upon the skin. Careful instruction in avoiding pressure forms an important part of the rehabilitation of the patient. So successful is this method of prevention that bedsores are no longer a problem in the Paraplegic Unit.

The bladder

The treatment of the paralysis of the urinary bladder which follows injury to the cord and roots is of vital importance The comfort, the well-being and even the life of the patient depend upon the proper initial treatment and correct re-education of the bladder.

Efficient bladder drainage must be instituted within 24 hours of the injury. There is considerable difference of opinion as to the best method of drainage Four methods are available.

Manual compression

The bladder is allowed to fill for 3–4 hours and is then partially evacuated by manual compression of the lower abdomen. The advantage of this method is said to be that by refraining from catheterization urinary infection can be avoided; most authors are agreed, however, that the persistent high residual urine which results from this method often results in urinary infection. Moreover, manual compression is difficult to apply and requires very skilful and conscientious personnel. The general conclusion appears to be that whilst the method may have advantages in selected cases, drainage methods are in general much more efficient.

Intermittent catheter drainage

Almost all authors are agreed that intermittent catheter drainage is the worst method. Repeated catheterization invariably leads to urinary infection, and should not be used for the paralysed bladder.

Suprapubic drainage

Many urologists consider suprapubic drainage to be the method of choice. Provided the suprapubic tube is properly introduced the method has many advantages. It certainly avoids distension of the bladder and the dangers of an in-dwelling urethral catheter.

The method has, however, many disadvantages. There is always a pool of urine present in the bladder, even if suction is used, and this residual urine is invariably infected. Leakage of urine occurs with some frequency round the suprapubic tube and this makes nursing difficult and adds to the danger of bedsores. Moreover, a period of urethral catheter drainage is always necessary later, during the re-education of the bladder, and the suprapubic sinus may take several weeks to close.

Indwelling catheter drainage

Indwelling catheter drainage is probably the method of choice. The bladder is drained by an indwelling Foley urethral catheter which is either left free to drain into a bottle or attached to some form of tidal drainage apparatus. Free drainage is simpler and probably more efficient. The catheter is connected to a tube which passes to a bottle beneath the bed, the whole being sterilized. The tube is disconnected daily and the bladder irrigated, using a Canny Ryall syringe, the solution used being a matter of individual choice. During the irrigation the bladder is distended with 250–300 millilitres of the fluid so as to maintain the capacity. The catheter is changed weekly with full aseptic precautions and catheter drainage continued until the bladder regains reflex activity.

The catheter must be of the correct size to fit the urethra, usually 18 French gauge, and must be passed with the strictest aseptic precautions. Provided the technique is correct such drainage can be continued for many weeks without the occurrence of dangerous urinary infection.

Physiotherapy

Throughout the early stages the paralysed limbs should be put through a full range of movements, at least daily, by a competent physiotherapist. This effectively prevents joint stiffness and contractures. The arm, the shoulder and the remaining trunk muscles must be exercised daily in order to develop their power and usefulness. Spring "developers" are useful for these exercises which must be carried out regularly under supervision; they must be carefully graduated so as not to exhaust the patient, and success depends upon stimulation of interest in the treatment.

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THORAX–CONGENITAL DEFORMITIES.

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FUNNEL CHEST (PECTUS EXCAVATUM)

Aetiology

This deformity is congenital in origin. The theory that rickets is the cause is untenable on all the evidence. Biochemical studies, radiology, and clinical examination of the patients offer no support to rickets being a causative factor. Add to this that most of these children are well nourished, coming from good homes.

All workers in this field agree that the deformity is due to the diaphragm exerting an abnormal pull on the xiphoid and the sixth costal cartilage, thereby dragging the sternum in on inspiration (Brown; 1939, 1951; Ravitch, 1951; Brodkin, 1953; Lester, 1954; Hirtz, 1954; and Hausmann, 1955). The following observations support the diaphragmatic theory.

In babies the deformity is labile and is produced only on vigorous inspiratory efforts, such as laughing and crying. In these infants, when deep inspiration is taking place the whole sternum is dragged back, producing a severe degree of funnel chest deformity. On relaxation of the diaphragm, that is, during expiration, the chest flattens out again and appears normal. The degree of the deformity depends directly on the degree of inspiration.

Experiments have been carried out by paralysing one phrenic nerve, and it has been observed in infants that this has produced an asymmetrical deformity on inspiration. Experiments have also been carried out with bilateral paralysis of the phrenic nerve, and in such cases the deformity on inspiration is almost completely abolished.

On screening these patients in the lateral position, backward retraction of the sternum occurs synchronously with the descent of the diaphragm.

Mechanics of production

That the diaphragm is the active agent which produces the deformity is accepted, but the precise anatomical defect in this fibro-muscular sheet, and the abnormal forces resulting from this defect, are still open to conjecture.

Brown (1939) stated that it was due to a short central tendon, but this cannot be so, as the deformity at no stage would be labile and capable of complete obliteration.

Paradoxical movement

Brodkin (1953) felt it was due to a poorly developed muscle in that part of the diaphragm which arises from the septum transversum, that is, the component of the diaphragm coming from the xiphoid and sixth costal cartilage. Because of its poor quality this portion is unable to act with the force that is required on the central tendon, and thus is pulled down and in with the central tendon on inspiration by the more powerful surrounding muscle. The result is that the lower end of the sternum is dragged back on inspiration (that is, paradoxical movement).

Normal diaphragmatic movement

... movement.

Types of deformity

There are four types of deformity.

Labile deformity

This is seen in babies. The deformity is present only on inspiration and is at its maximum when deep inspiratory efforts are made. In repose the chest looks normal.

Established deformities

There are three types in this group.

Type I.—The sternum is sharply angulated, usually at the level of the third or fourth costal cartilage. The angulation of the costal cartilages occurs well medially



FIG. 109—A typical Type I deformity It is localized The angulation is steep and close to the sternal margin There is no flare of the costal margin



FIG. 110—A typical Type II deformity. It is diffuse The angulation occurs farther out There is a marked flare of the costal margin.

and is acute. This results in the sort of depression you can "put your fist in". While kyphosis and abdominal protuberance may or may not be associated with this. "rolling out" or "flare" of the costal margin is not present. The acute angulation of the costal cartilage begins at the fourth costal cartilage and continues through to the seventh. Much less often the third costal cartilage also is acutely angulated (Fig. 109).

Type II.—This deformity is more diffuse The sternum is not as steeply angulated as in Type I. Hence the angulation of the costal cartilages is less severe and it takes place farther away from the sternum It is not as localized as Type I and it resembles an inverted plateau. Protuberance of the abdomen and kyphosis may be present, but a flare of the costal margin is always present. This deformity is more diffuse than Type I, and the third, and often the second, costal cartilages are involved (Fig. 110).

Type III.—The basic feature of this type is asymmetry. It may resemble Type I on one side and Type II on the contralateral side, and there is a rotation of the sternum, usually to the left. There is no doubt that this tilt of the sternum is the basic feature which causes the asymmetry of the costal cartilages.

It is usual in all types for the xiphoid to be impalpable, and paradoxical movement on inspiration depends on the degree of fixation of the deformity.

Symptomatology

It has been denied that these patients can have symptoms (Evans, 1946). It is true that many cases, and some with an extreme degree of deformity, deny any disability. Many of these cases, however, suffer a severe disability, particularly adults. It is only natural that such cases are commonly seen where curative surgery is performed. Many authors have recorded cases in which the patient has been disabled by this condition (Sauerbruch, 1931; Alexander, 1931; Ochsner and de Bakey, 1938; Carr, 1932, 1933; Master, 1949; Dorner, 1950; Ravitch, 1951; Lester, 1954; Chin and Adler, 1954; and Hausmann, 1955)

It is not surprising that symptoms should occur, as there is impairment of pulmonary function and a marked rotation of the heart to the left.

The patients seen in clinics can be put into four groups. Group (1) seek advice only for cosmetic reasons, and deny symptoms. The majority of patients in this group are children. Group (2) have a history of frequent colds and bronchitis These symptoms often date from their first winter, and come with such a degree of frequency as to cause concern to the parents and to the doctor. Such cases are very common. It is not surprising that this should happen. Owing to the deformity these patients have an ineffective cough and they are prone to sputum retention with infection at both lung bases. Group (3) again complain of repeated bronchitis and dyspnoea, and inability to keep up with people of their own age in activities such as walking, running and swimming. They complain that they are always behind and are distressed in comparison with their fellows. Group (4) complain of dyspnoea which is progressive and has become disabling Walking up stairs or up hills causes dyspnoea On exertion, as well as dyspnoea, they suffer from palpitations, pain in the chest, and syncope. The history of repeated chest infection is very common. In this very severe group, patients have been seen complaining of dysphagia as well.

The common factor in all groups is that of repeated chest infections, and dyspnoea of varying grades.

Clinical examination

The clinical examination is the diagnosis. There should be no confusion between this deformity and any other of the many chest deformities which occur, such as congenital sternal prominence, manubrio-sternal prominence (pigeon chest), congenital lateral sulci, and deficiencies of the chest wall.

The degree of backward displacement of the sternum should be noted, and whether there is retraction of the sternum on inspiration (paradoxical movement), or whether the sternum is now fixed and has attained the maximum degree of displacement that is possible

This paradoxical movement of the sternum is an important feature, particularly in young children, for a severe degree of paradox of the sternum is so often associated with repeated episodes of lung infection.

Kyphosis should be observed, and whether it is fixed or mobile. It is rare for it to be fixed in children. Other features are the presence of protuberant abdomen and a flaring of the costal margin The latter is never found in Type I, but is common in Type II.

The clinical examination is carried out to assess (*a*) the type of deformity, and (*b*) the degree of the deformity

... excellent cosmetic result can be obtained in Type I. The ... ost cases. In Type II, cosmetic results ... to eradicate the deformity completely, and at the best it can only be 80 per cent corrected. These patients are still left with the inverted plateau type of deformity, but it is less severe. However, it should be done for cosmetic and prophylactic reasons, as it prevents further progression of the



Fig 111 —The result obtained after repair of the Type II deformity The deformity has been improved and the posture improved, but there is still present an obvious degree of sternal depression

deformity and allows the patient to attain a much better posture (Fig 111). Type III is variable, but it is not usual to get a complete obliteration of the deformity, as in Type I.

Anaesthesia

Anaesthesia for this operation presents little difficulty. Surgery is facilitated when spontaneous respiratory movements are abolished and pulmonary inflation is produced by controlled artificial respiration. Such artificial respiration, under positive pressure, also minimizes the disturbances of the open pneumothorax produced if the pleural cavity is inadvertently opened during resection of the costal cartilages or during mobilization of the sternum.

Rectal thiopentone is favoured as a basal narcotic in small children Induction in older children and adults is by the intravenous injection of thiopentone and a curarizing agent Maintenance of anaesthesia is by endotracheal nitrous oxide and oxygen, often supplemented by intravenous pethidine and further curarization when necessary.

[illegible]

...is usually small and blood transfusion is not normally required. Cardiac disturbance during operation has not been encountered.

Operative technique

Modified operation

This operation should be performed only when there is no degree of fixity. It is done, in other words, on a completely labile deformity, and for that reason it is only performed on babies in the first year or two of life. The modified operation will not correct an established deformity.

The object is to remove the attachment of the diaphragm from the chest wall at the point where it is pulled in and thus stop the inevitable progression of the deformity.

By a small transverse incision at the level of the sterno-xiphoid junction, the xiphoid is detached from the sternum and the upper half of the xiphoid is excised. A short length of the sixth and seventh costal cartilage is removed, leaving the posterior layer of the perichondrium. The attachment of the perichondrium to the sternum is divided and a small segment of the adjacent perichondrium is removed. The reason for excising part of the xiphoid and the perichondrium is to prevent re-attachment which will occur readily in babies.

Full operation

This operation is employed in the great majority of cases. It should be used in all cases where there is any degree of deformity at rest.

In adults the incision should always be a midline, longitudinal incision, extending from the level of the third costal cartilage to below the xiphoid. In children a transverse incision at the level of the fourth costal cartilage, running out to the nipple-line on either side, can be used. The only advantage that the transverse incision has over the longitudinal is that it is easier to get farther out on the sixth and seventh costal cartilages. The incision used is purely a matter of personal preference for the surgeon, and the operation can be done equally well through either.

The skin and subcutaneous tissues are undercut, and the edges are retracted. Any tissue that overlies the sternum is cleared away The origin of the pectoral muscles on either side is then seen. The pectoral muscles are cleared off the costal cartilages on both sides. This is best done by sharp dissection with fine scissors of the Boyd's type, clearing up along the costal cartilages first, and then cutting the intervening muscle between the cartilages. Bleeding will be encountered in each interspace, the vessels being the perforating branches of the internal mammary arteries. These are easily controlled by diathermy. The reflection of the muscle should be carried out until the site of angulation of the cartilage is reached The sixth and seventh costal cartilages are overlaid by the rectus abdominis. They can be displayed by carefully defining the upper and lateral border of this muscle and retracting it out of the way. Alternatively an incision can be made straight through the muscle However, it is preferable not to cut through the muscle but to retract it after having mobilized its upper portion.

The sternum and costal cartilages are now displayed and all the deformed costal cartilages must be removed to just beyond the site of angulation. Any costal cartilage which is angulated to any degree must be removed, and this usually means the third to the seventh. It is important to leave the posterior layer of the perichondrium. This is best achieved by running the diathermy point along the upper and lower borders of the cartilage; then by a blunt rugine clearing a small portion of the upper and lower borders. A Mayo's towel clip then takes a firm bite into this area and by strong traction the cartilage is bowed up. The cartilage is then cut into with a knife at the most convex point, and if firm traction is maintained, as the knife approaches the

posterior layer of the perichondrium, the cartilage will divide, leaving this perichondrial layer intact. The perichondrium can then be stripped off the cartilage in both directions, by either a dissecting swab or a blunt rugine. The intercostal muscles are cut off the upper and lower borders by scissors. If this routine is followed the dissection of the perichondrium from the cartilage is a simple matter. This manoeuvre is repeated on both sides from the third to the seventh costal cartilages

The xiphoid is then gripped with a towel clip and elevated firmly. With a small-bladed knife a nick is made in the perichondrium of the seventh costal cartilage, and sharp scissors are placed through this behind the xiphoid. The xiphoid is then cut from the sternum by cutting down on to the scissors with a knife. The upper portion of the xiphoid is then resected.

The lower end of the sternum is now gripped with a towel clip and forcibly elevated With a finger the back of the sternum is swept clean of all surrounding tissue, taking

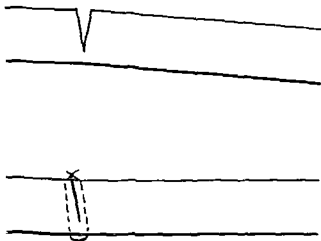


FIG 112 —The extent of the wedge osteotomy, which is extended through practically to the posterior table, when the sternum is lifted forward this posterior table is fractured

care to reflect the pleura at either side. This clearance of the retro-sternal space should be carried up to the level of the second costal cartilage After this is done, the pleura must be inspected for any tears. Having done this, the perichondrium of the sixth and seventh costal cartilages is detached from the sternum, and the sternum is again elevated to see if any of the other layers of perichondrium is holding it down. Any layer which obstructs the elevation of the sternum should be detached from it. It may sometimes be necessary to detach the fifth and the fourth, but rarely.

A transverse osteotomy must now be performed at the site of angulation of the sternum. The periosteum is reflected back from the elected site by a transverse incision through it. A transverse wedge osteotomy is then performed in the sternum down to the posterior table, but not through it. This can easily be done by a sharp chisel The sternum is then lifted well forward, fracturing the posterior table at the site of the osteotomy.

The tip of the sternum is again elevated well up by traction on a Mayo's towel clip, and two drill holes are made above and below the site of the osteotomy, the mediastinum being protected by a copper strip along the posterior aspect of the sternum. When this has been completed a double ligature of 25 thread is carried through the drill holes on a needle, and these are tied firmly with the sternum held in the over-corrected position (Fig 112) The periosteum is then apposed by two or three interrupted sutures of 40 thread.

The extent of the resection is shown in Fig. 113 It is usual to resect about ½ inch of the perichondrium of the sixth and seventh cartilage to avoid re-attachment.

The pectoral muscles are now sewn to each other across the mediastinum by interrupted sutures. The space is then carefully examined for any bleeding points, the most likely being the anterior intercostals or branches coming from the internal mammary on either side. The pleura is again inspected to make sure there is no tear. If a small tear is present, it can be repaired, the anaesthetist fully inflating the lung when the final closure is made. If the tear is extensive or the pleura too fragile to hold sutures, it can be left open. The space is then drained by a small stab wound below the main

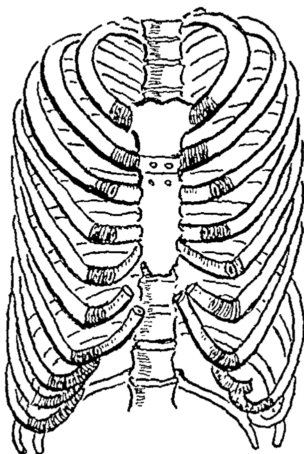


FIG 113 —It is seen that the costal cartilages have been removed sub-perichondrially from the third to the seventh A portion of the perichondrial layer of the sixth and seventh has been removed. A wedge osteotomy has been performed above

incision. Drainage is best performed by a small tube and this tube must be connected to underwater drainage. Drainage is important as there is always a sero-sanguinous effusion, and if left it can place strain on the suture line. While careful inspection may have been carried out, it is possible unwittingly to have made a nick in the pleura, and if the drainage is open, then the patient will have a total pneumothorax. Hence drainage should always be of underwater type.

The skin is now closed by interrupted sutures. No supports are used such as rib struts or wire. These are unnecessary and can be painful

Post-operative care

There is nothing special that need be done. It is important of course that these patients should cough adequately, and that after the removal of the tube, which is usually on the second or third day, a careful watch be kept on the wound for fluctuation If there is any fluctuation, then the fluid should be aspirated. The patients are got up on the second or third day, and immediately their posture is taken in hand by the physiotherapists. This is a most important aspect of post-operative care, and very important in children. Their bad postural habits are long established and therefore are difficult to break and it is always advisable to train the parents in postural treatment as well as the patients, so that this can be carried out at home.

Post-operative complications

Paradoxical respiration

Paradoxical respiration is always present for 2 or 3 days, but never to a degree enough to worry the patient. If severe troublesome paradox occurs, it is the result of a pneumothorax This can happen if the drainage tube is not connected to an underwater seal. Once the pneumothorax is obliterated by aspiration, severe paradox will cease.

Wound rupture

This will occur on removal of the suture if adequate aspiration has not been carried out

In the main, post-operative complications are extremely few. In a series of fifty cases, these are the only two that have occurred.

Results

Results can be divided under three headings.

Symptomatic

The symptomatic improvement in all cases is uniformly good When the patient has such symptoms as frequent chest infection, dyspnoea, pain in the chest, palpitations, and syncope, these can be cured In a large series, there have been severely disabled patients who have led a semi-invalid life, but have now returned to full activities. Even in the asymptomatic group there is a persistent story of improvement.

Cosmetic

In Type I the cosmetic improvement is excellent Most have 100 per cent correction of the deformity, and at worst it is 90 per cent.

In Type II it is more disappointing. An 80 per cent correction of the deformity may be obtained, but sometimes less

In Type III the results are variable and unpredictable, but at least a 70 per cent correction should be obtained and sometimes 100 per cent

Recurrence

Recurrence of the deformity is unusual, but it does occur, and there are two factors which are responsible

Inadequate surgery.—Failure to drill the manubrium at the site of the osteotomy, and relying on periosteal sutures only

Failure to detach any band of perichondrium which is anchoring the sternum, and failure to excise the upper half of the xiphoid and part of the sixth and seventh perichondrium, thus allowing re-attachment.

Bad postural habit.—The other factor responsible for recurrence is the continuation of bad postural habits, particularly in children.

DEFICIENCIES OF THE CHEST WALL

Definition

These deficiencies are not common, but are seen mostly in the upper, anterior part of the chest wall There may be an absence of the costal cartilages with or without associated absence of part of the sternum.

Aetiology

There is no doubt that they are congenital in origin and there may be associated abnormalities, such as a deformity of the hand on that side, asymmetry of the upper limbs, and absence of the pectoral muscles, either entirely or in part.

Clinical signs

The deficiencies are apparent on clinical examination. There may be paradoxical movement of the chest wall at the site of the deficiency, and this paradox will always increase if pulmonary infection occurs. Abnormal cardiac pulsation may be present. Such examples are deficiencies on the left side over the pulmonary artery or over the myocardium itself. Marked pulsation is apparent in the area, and this is what is troublesome to the patient.



FIG 114—Deficiency of part of the sternum and the costal cartilage, with absence of the sternal portion of the pectoralis major. Marked cardiac pulsation was present under the sternal and costal cartilage deficiency

Indication for repair

Where marked cardiac pulsations or pulmonary artery pulsations are present, it is advisable to carry out repair. The patient has a fear of damage to his heart and is often seen wearing a large leather cuirass, having been instructed to indulge in no vigorous activities. Naturally this is irksome to a boy (Fig. 114)

Technique of repair

It is often possible to lay in bone grafts across the site of the deficiency. Split bone graft is the most effective method, and the bone is readily obtained by sub-periosteal resection of one of the boy's own ribs. It is necessary to freshen the donor sites by reflecting the periosteum and scarifying the bone. The graft should be fixed by drill holes and transfixion sutures.

Results

Operation results in giving support to the area, obliterating the abnormal pulsations, and giving the patient confidence, so that he can indulge in full activities.

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URETER-TRANSPLANTATION INTO THE ILEUM

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PRINCIPLES OF URINARY DIVERSION

Diversion of the urinary stream from its normal course through the bladder is carried out following cystectomy for carcinoma of the bladder or as a palliative procedure in that condition to relieve pain and frequency; for the contracted bladder which may follow healed tuberculosis; for interstitial cystitis or recurrent attacks of long-standing chronic cystitis; for the treatment of ectopia vesicae; for the relief of incurable vesico-vaginal or vesico-recto-vaginal fistula following injuries at child-birth or after radiotherapy for carcinoma of the cervix; and as a part of the operation of pelvic exenteration for extensive pelvic cancer.

Urinary diversion may be carried out by a number of different methods depending partly on the views of the surgeon, and partly upon the anatomical conditions present in the patient; the most suitable method for any given pathological state is often still controversial. The methods which are available are cutaneous ureterostomy, transplantation of the ureters into the colon and transplantation of the ureters into an artificial bladder made from a segment of intestine; such a "bladder" may be either a conduit for urine or it may be a reservoir. The ileal bladder is one of the varieties of artificial bladder.

Bilateral cutaneous ureterostomy

Bilateral cutaneous ureterostomy is practised by a small minority of surgeons. One disadvantage is that when the ureter has been mobilized in order to bring it out through the abdominal wall, a failure of the blood supply of the end of the ureter has sometimes led to terminal necrosis or stricture, the ureter retracting to the bottom of a small septic cavity from which secondary urinary fistulae may develop. A further disadvantage is that it is difficult to fit an apparatus to the abdominal wall which will collect the urine from the two ureterostomy openings without inconvenient leakage.

Uretero-colic anastomosis

The orthodox operation for urinary diversion when the rectum and colon are intact and the sphincter mechanisms of the anal canal are normal is uretero-colic anastomosis. The techniques most commonly practised are those of Stiles (1911), in which the ureter is secured to the wall of the sigmoid after having been passed into its lumen through a small opening; and of Coffey (1911), in which the ureter is made to pass into the lumen of the intestine through a tunnel in the submucous layer of the sigmoid and its end is then secured to the wall of the intestine. These two methods are followed not infrequently by the development of varying degrees of stricture at the anastomosis, leading to slight or medium-grade hydronephrosis which may perpetuate a renal infection. The methods of Nesbit (1948) and of Cordonnier (1949) which consist of a direct mucosa-to-mucosa union between the upper end of the divided ureter, cut obliquely so as to provide an elliptical opening, and the mucosa of the colon, generally avoid stricture formation at the anastomosis, but because of

the absence of a valve there may be reflux of colonic content to the kidneys with consequent pyelonephritis. The method of Leadbetter (1951) combines the principle of direct mucosa-to-mucosa union between the end of the ureter and the mucosa of the colon, with a valve to prevent reflux. None of these methods gives satisfactory long-term results in every case.

When the rectum has been removed and a colostomy has been made, urinary diversion can still be carried out if the bladder has also been removed by transplanting the ureters into the colon above the colostomy opening, but this procedure results in the highly inconvenient wet colostomy. Alternatively, the ureters can be transplanted into some form of artificial bladder made from a loop of bowel.

Artificial bladder

When the rectum is still present but its sphincter mechanisms have been damaged by injury or disease or are congenitally inadequate as in some cases of spina bifida, uretero-colic anastomosis is not appropriate, and if urinary diversion is then necessary the surgeon may elect to perform either bilateral cutaneous ureterostomy or he may divert the urine into an artificial bladder of which there are several varieties.

Artificial bladder made from the rectum and sigmoid colon

This procedure was first used in dogs by Mauclaire (1895) and in human beings by Remedi (1906) and Kronig (1907); these workers divided the upper end of the rectum and implanted the two ureters into its invaginated upper end, bringing the proximal end of the divided intestine to the surface as an end-colostomy. The writer, using a similar technique, has used the rectum and the whole of the sigmoid colon as an artificial bladder in eight cases Since the cavity of the "bladder" is free from faeces, and appears to develop only a very low bacterial content, and also because the amount of elecrolyte absorption is small on account of the relatively short length of intestine which is used, these cases have been clinically very well. They have shown no evidence of ascending renal infection during a post-operative period of three years or more Some degree of electrolyte imbalance has been noticed in some cases but it has been readily corrected by the usual methods. A colostomy is the price which has been paid for a good clinical end-result

Artificial bladder constructed from the isolated ileo-caecal region of the intestine

This procedure was first carried out by Verhoogen (1908) and by Makkas (1910) and has recently been strongly advocated by Merricks and his colleagues (1951) A loop of terminal ileum, together with the caecum and ascending colon, is isolated and intestinal continuity is restored by an ileo-colic anastomosis. The ureters are transplanted into the caecum and the terminal ileum is brought to the surface as an artificial urethra through which the patient catheterizes himself at intervals. Once again the ureters drain into a faeces-free cavity Electrolyte imbalance has been reported (Moore, 1953). The need for frequent catheterization is a disadvantage of this method.

Ileal bladder

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PHYSIOLOGICAL AND PATHOLOGICAL CONSEQUENCES OF URINARY DIVERSION INTO THE INTESTINE

When any of the operations for urinary diversion are carried out, the kidneys are deprived of the delicate valve mechanism at the uretero-vesical junction, which

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Changes consequent on the incorporation of the ileum into the urinary tract

When the ileum is incorporated into the urinary tract as in the operation of ileocystoplasty, or when a long loop of ileum is used to replace a portion of the ureter excised because of injury or disease (Pyrah and Raper, 1955), or in the artificial closed ileal bladder joined to the urethra after cystectomy (Pyrah, 1956), the urine is in contact with a loop of ileum of varying but limited length, almost continuously, except when the bladder is completely empty, in these cases the ileum acts as a *reservoir* for urine. When a loop of ileum is used as a *conduit* for urine, as in the simplest form of ileal bladder (with a terminal ileostomy), urine is also in contact with the ileal mucosa, but only in small amounts since external drainage is quite free. Although the use of the ileum for such purposes has only come into use in the last four or five years and the total number of cases operated on is still comparatively small, no clinical syndrome similar to that following uretero-colic anastomosis has so far been reported and the incidence of hyperchloraemic acidosis has been low and in some series absent

Bricker (1952) reported hyperchloraemic acidosis in one patient with an ileal bladder, who developed bilateral hydronephrosis of severe degree which later required operative revision; this associated pathology may have partly accounted for the imbalance. Wilson (1953) reported a temporary hyperchloraemic acidosis, which disappeared in two or three weeks, in a case of pelvic exenteration and ileal bladder performed for pelvic cancer. Annis, Hunter and Wells (1954) reported 21 patients with ileocutaneous ureterostomies, the majority of whom showed blood levels of the CO_2-combining power either at, or slightly below, normal while the serum chloride levels were normal except in 4 cases in which there was hyperchloraemia. The serum potassium levels varied widely, 6 cases showing values slightly below normal, while several showed high normal and 3 had top normal or higher values These findings were laboratory figures and no cases showing clinical evidence of hyperchloraemic acidosis were recorded.

Bricker, Butcher and McAfee (1954) reported 5 cases (2 fatal) of convulsive states which they thought might have had as cause some unrecognized fluid or electrolyte disturbance. These workers have not, however, found any complication proved to arise from the absorption of urinary constituents; they found hyperchloraemia in only 2 cases in their series of 65 patients, and in these, ileal bladder substitution had been performed for severe hyperchloraemic acidosis complicating previous uretero-sigmoidostomy. In 23 cases reported by the writer in which the ileum had been incorporated into the urinary tract for a variety of purposes (Pyrah, 1956), and which included 6 cases of ileal bladder, no case of hyperchloraemic acidosis was noted, nor were any symptoms observed which could be attributed to electrolyte imbalance

In order to study experimentally the migration of sodium, chloride and potassium ions across the mucosa of the ileum, perfusion experiments using radioactive isotopes were carried out in a case of ileocystoplasty, and also in a woman suffering from uraemia due to congenital cystic kidneys for whom a two-foot loop of ileum had been used as an artificial kidney (Pyrah and his colleagues, 1955) It was found that sodium and chloride ions migrate across the mucosa of such a bladder into the blood stream and also in the reverse direction from blood to perfusing fluid. There was a small net uptake of sodium and chloride ions in approximately equal amounts into the blood stream Potassium ions were also shown to move simultaneously in both directions across the ileal wall; it was shown that when the potassium concentration of the perfusing fluid was approximately three times that of the blood plasma (or approximately half the concentration of an average urine) there was a net absorption of potassium from the loop; it seems likely, therefore, that some absorption of potassium will take place when a loop of ileum is anastomosed to the

is the principal guard against ascending renal infection, a complication which may, in consequence, follow any of these procedures. When urine is diverted from its natural channels to any part of the intestine certain physiological changes occur in the composition of the urine which can sometimes be harmful. It is desirable to consider these changes in order to justify the use of the ileum as a urinary conduit or reservoir and also to understand the reasons which have led some surgeons to advocate the use of the ileal bladder to the exclusion of uretero-colic anastomosis as a means of urinary diversion.

Changes consequent upon uretero-colic anastomosis

When surgeons began to perform the operation of uretero-colic anastomosis with increasing frequency it was found that some patients, though making a good recovery from the operation, did not ultimately achieve normal health; a few patients gradually failed and died in coma.

Ferris and Odel (1950) first accurately described the clinical syndrome of electrolyte imbalance which was responsible for the observed sequence of events. Symptoms may start soon after operation, especially if there is an attack of pyelonephritis; or their onset may be delayed for months or years. The early symptoms, which may persist for a long time, are thirst, a distaste for food and loss of energy; coincident with these symptoms the face becomes shrunken and pallid, the tongue coated, the skin dry, and there may be evidence of anaemia. More important symptoms are the onset of nausea with occasional vomiting; an acute collateral illness such as acute bronchitis may precipitate urgent symptoms. There is then a complete distaste for food, with consequent wasting and loss of skin turgor; there is a raised pulse-rate and Kussmaul's breathing. Continued nausea and vomiting may be followed by increasing weakness, drowsiness and coma which may prove fatal in a few days unless vigorous corrective treatment is instituted.

Ferris and Odel (1950) found that a high proportion of patients who had undergone uretero-colic anastomosis had a hyperchloraemia and also an acidosis, as shown by a reduced CO_2-combining power; the blood urea was also frequently elevated. These findings were soon confirmed by other workers and a large series collected by Jacobs and Stirling (1952) showed similar results. The mechanism of this electrolyte imbalance has been studied by Ferris and Odel (1950), Lapides (1951), Parsons and his colleagues (1952a and b), and by Annis and Alexander (1952). These researches, which have been summarized elsewhere (Pyrah, 1954), appear to show that the electrolyte imbalance results from two principal causes: (1) a differential absorption of chloride and sodium ions from the colon, chloride ions being absorbed in excess of sodium ions, resulting in a hyperchloraemic acidosis; these changes depend upon the physiological properties of the intact colonic mucosa; and (2) ascending infection from the colonic content to the kidneys, resulting in impairment of renal function, and especially of tubular function, so that the kidneys cease to play their normal part in securing homeostasis following the absorption of the electrolytes.

It is relevant to this discussion to state that the hyperchloraemic acidosis can be corrected by prohibiting the use of salt at the table, though allowing it in the cooking of food, by the daily administration of 4 grammes of bicarbonate of soda, and by encouraging the patient to micturate at frequent intervals by day and at least once during the night, in order to prevent the accumulation of a large amount of urine in the colon.

Careful follow-up and frequent biochemical examinations of the blood are a necessary routine in all cases. Any incipient renal infection must be treated. Since 1951, when this mode of supervision and treatment became a routine practice, we have had no cases of severe illness or coma consequent upon electrolyte disturbance secondary to uretero-colic anastomosis, and the general well-being and physical fitness of the patients have been greatly improved.

Changes consequent on the incorporation of the ileum into the urinary tract

When the ileum is incorporated into the urinary tract as in the operation of ileocystoplasty, or when a long loop of ileum is used to replace a portion of the ureter excised because of injury or disease (Pyrah and Raper, 1955), or in the artificial closed ileal bladder joined to the urethra after cystectomy (Pyrah, 1956), the urine is in contact with a loop of ileum of varying but limited length, almost continuously, except when the bladder is completely empty; in these cases the ileum acts as a *reservoir* for urine. When a loop of ileum is used as a *conduit* for urine, as in the simplest form of ileal bladder (with a terminal ileostomy), urine is also in contact with the ileal mucosa, but only in small amounts since external drainage is quite free. Although the use of the ileum for such purposes has only come into use in the last four or five years and the total number of cases operated on is still comparatively small, no clinical syndrome similar to that following uretero-colic anastomosis has so far been reported and the incidence of hyperchloraemic acidosis has been low and in some series absent.

Bricker (1952) reported hyperchloraemic acidosis in one patient with an ileal bladder, who developed bilateral hydronephrosis of severe degree which later required operative revision; this associated pathology may have partly accounted for the imbalance. Wilson (1953) reported a temporary hyperchloraemic acidosis, which disappeared in two or three weeks, in a case of pelvic exenteration and ileal bladder performed for pelvic cancer. Annis, Hunter and Wells (1954) reported 21 patients with ileocutaneous ureterostomies, the majority of whom showed blood levels of the CO_2-combining power either at, or slightly below, normal while the serum chloride levels were normal except in 4 cases in which there was hyperchloraemia. The serum potassium levels varied widely, 6 cases showing values slightly below normal, while several showed high normal and 3 had top normal or higher values These findings were laboratory figures and no cases showing clinical evidence of hyperchloraemic acidosis were recorded.

Bricker, Butcher and McAfee (1954) reported 5 cases (2 fatal) of convulsive states which they thought might have had as cause some unrecognized fluid or electrolyte disturbance These workers have not, however, found any complication proved to arise from the absorption of urinary constituents, they found hyperchloraemia in only 2 cases in their series of 65 patients, and in these, ileal bladder substitution had been performed for severe hyperchloraemic acidosis complicating previous uretero-sigmoidostomy. In 23 cases reported by the writer in which the ileum had been incorporated into the urinary tract for a variety of purposes (Pyrah, 1956), and which included 6 cases of ileal bladder, no case of hyperchloraemic acidosis was noted, nor were any symptoms observed which could be attributed to electrolyte imbalance

In order to study experimentally the migration of sodium, chloride and potassium ions across the mucosa of the ileum, perfusion experiments using radioactive isotopes were carried out in a case of ileocystoplasty, and also in a woman suffering from uraemia due to congenital cystic kidneys for whom a two-foot loop of ileum had been used as an artificial kidney (Pyrah and his colleagues, 1955). It was found that sodium and chloride ions migrate across the mucosa of such a bladder into the blood stream and also in the reverse direction from blood to perfusing fluid. There was a small net uptake of sodium and chloride ions in approximately equal amounts into the blood stream Potassium ions were also shown to move simultaneously in both directions across the ileal wall; it was shown that when the potassium concentration of the perfusing fluid was approximately three times that of the blood plasma (or approximately half the concentration of an average urine) there was a net absorption of potassium from the loop; it seems likely, therefore, that some absorption of potassium will take place when a loop of ileum is anastomosed to the

bladder. If renal function is normal, homeostasis of the potassium could be achieved, but if renal function is impaired there is real danger of hyperkalaemia. In this regard it is interesting to note that Tasker (1953) reported a patient upon whom an ileocystoplasty had been performed for a contracted bladder and who died on the twelfth post-operative day with a flaccid paralysis which may have been due to potassium intoxication: he also showed that in dogs in which an ileocystoplasty had been performed, the venous blood draining from the ileal graft when the bladder was filled with urine contained a significantly higher potassium content than when the bladder contained no urine.

INDICATIONS FOR THE CONSTRUCTION OF AN ILEAL BLADDER

Spina bifida

In cases of spina bifida with urinary incontinence and flaccid anal sphincter it is inappropriate to perform a uretero-colic anastomosis, and in such cases an ileal bladder gives very good results; since there is only one external urinary opening it is to be preferred to bilateral cutaneous ureterostomy. Some of these cases do not survive childhood because of infection in the urinary tract and because of hydrocephalus; those who survive may develop a moderate control of rectal function in early adolescence. It is therefore reasonable to wait until the child is between the ages of 12 and 15 years before constructing an ileal bladder. Since there is great variation in these patients, each case must be judged on its merits. It is necessary to ensure that the child and the parents will co-operate and, as far as possible, to guard against possible psychological disturbances in the child.

For vesico-vagino-rectal fistula resulting from radiotherapy for extensive cancer of the cervix uteri or from actual cancer

In such cases uretero-colic anastomosis would be of no value and the ileal bladder is the best method of relieving the complete urinary incontinence; it may have to be combined with a colostomy if the rectal fistula cannot be repaired.

In cases of pelvic exenteration for extensive pelvic cancer

In a relatively few cases of extensive pelvic cancer originating either in the cervix uteri, the rectum or the bladder and in which the malignant mass is still movable, though the involvement of neighbouring pelvic organs has rendered the more limited formal radical procedures impracticable, pelvic exenteration, removing the rectum and sigmoid, uterus and adnexa, together with the bladder and lower ureters, has been performed. The ureters in such cases have been transplanted into the upper part of the remaining colon, giving the patient a so-called wet colostomy; this, however, is unpleasant and socially difficult to manage.

As an alternative to a wet colostomy, Bricker (1950) advocated the transplantation of the ureters into an isolated loop of ileum brought out as an ileostomy in the right iliac fossa; an end-colostomy is made in the left iliac fossa. In a series of papers Bricker (1950, 1952a, 1952b) and Bricker, Butcher and McAfee (1954) have shown that such a procedure can be carried through so as to give the patient reasonable comfort and enable her to lead an active life, and the authors report a series of 81 cases The results as far as the ileal bladder is concerned have been very good and there has been a low incidence of hydronephrosis and renal infection and no hyperchloraemic acidosis.

Untreated ectopia vesicae in adults with grossly impaired renal function

In late, untreated, or failed cases of ectopia vesicae in adults, renal function may be very poor because of recurrent attacks of ascending renal infection and subsequent

hydronephrotic dilatation. Moreover, in some cases in this group there is defective tone in the anal sphincter. An ileal bladder after cystectomy is then a more suitable operation than a uretero-colic anastomosis.

Following cystectomy for carcinoma of the bladder as an alternative to uretero-colic anastomosis

The ileal bladder following cystectomy is carried out by a small minority of surgeons who have discarded almost entirely the operation of uretero-colic anastomosis on the ground of its uncertain results. Bricker, Butcher and McAfee (1954) found such satisfactory results following the construction of an ileal bladder in cases requiring pelvic exenteration that they extended its use to cases of carcinoma of the bladder requiring cystectomy; they reported 16 cases. Annis, Hunter and Wells (1954) reported 17 surviving cases in which they had used an ileal bladder following cystectomy for cancer of the bladder When joining the ureters to the ileum, the techniques of Stiles, Kidd and Coffey were preferred to that of Nesbit which they used in some cases. In discussion of their results they state that they "are utterly opposed to the whole concept of uretero-colic anastomosis". A majority of surgeons still favour uretero-colic anastomosis as the method of choice though some consider that the ileal bladder should be used following cystectomy in patients whose renal function is impaired. It is therefore desirable to refer briefly to the arguments in favour of and against the use of these two methods

Choice of method

The operation of constructing an ileal bladder together with cystectomy is a very long surgical procedure, tiring to the surgeon and, in some cases, exhausting to the patient, though with modern methods of combating shock and infection it is usually very well borne It adds to the two uretero-intestinal anastomoses, an ileo-ileal anastomosis, which may be an additional cause of morbidity. Since urine is to drain into a faeces-free cavity usually having a relatively low bacterial content, the incidence of ascending renal infection is not high, though it does occur occasionally. The follow-up pyelograms of the kidneys are satisfactory in a high percentage of cases, as will be seen later. The patient, however, has a permanent urinary fistula through the abdominal wall, which is a drawback. The incidence of hyperchloraemic acidosis is extremely low

On the other hand, the operation of uretero-colic anastomosis is simpler and shorter than the construction of an ileal bladder, and since 1951 and 1952, when the causes and treatment of hyperchloraemic acidosis, described previously, were worked out, this condition has ceased to be the serious problem that it was prior to those years Patients look clinically well and provided always that they co-operate intelligently in their own treatment, are able to lead useful lives. Moreover, increasing experience of the operation of uretero-colic anastomosis should lead to better technical results with fewer leaks and fewer strictures The writer therefore considers that in a case with good renal function, requiring urinary diversion, uretero-colic anastomosis is to be preferred to the operation of the ileal bladder following cystectomy for carcinoma of the bladder.

There remains the difficult problem of which operation to select in cases requiring urinary diversion in the presence of impaired renal function. Many surgeons, including the writer, have transplanted into the colon the ureters of solitary hydronephrotic kidneys following healed vesical tuberculosis, in which renal function was defective, and have obtained good late results, in such cases the dilated ureter allows the easy performance of a Cordonnier mucosa-to-mucosa type of anastomosis If recurrent attacks of ascending infection occur in such cases, life may be jeopardized, and the ureters may be transplanted into an ileal bladder at a later date, but the arguments

against uretero-colic anastomosis do not seem to the writer to be strong enough to advise the operation of an ileal bladder as the primary procedure in every case which has impaired renal function. In cases with very grossly impaired renal function, however, there is a stronger case for using the ileal bladder instead of uretero-colic anastomosis, since one or two attacks of infection may overwhelm a patient following the latter procedure; on the other hand the construction of an ileal bladder may itself tax the strength of such a patient. The matter, therefore, must be one for the judgment of the individual surgeon having regard to the confidence which he has in his own techniques. Probably there are a few cases in this last group in which an ileal bladder is more suitable than a uretero-colic anastomosis, but a final decision on this difficult matter is not yet in sight

Some surgeons have argued that if a patient is expected to have many years of survival, for instance, following cystectomy for diffuse papillomatosis of the bladder, the construction of an ileal bladder is a more rational procedure than uretero-colic anastomosis since with the latter procedure slow deterioration in renal function may be expected to occur, such, in fact, is not always the case. The writer would not, therefore, at present accept the argument of possible long-term survival of the patient as being one in favour of the ileal bladder as against uretero-colic anastomosis, though if, in a given case, renal function did deteriorate seriously during the years, the construction of an ileal bladder could then be considered as a secondary procedure.

THE OPERATION

Preparation of the patient

The patient is prepared for operation by being given a low residue diet and 250 milligrams of aureomycin 4-hourly for 4 days before operation; the colon is washed out on the 2 mornings before operation and on the evening before, an enema is given.

The incision

The abdomen is opened by a left paramedian incision, extending from just above the umbilicus to the symphysis pubis A general inspection of the abdomen is made. The lowest part of the ileum is carefully examined and a suitable coil in the lowest 3 feet of the ileum, about 12 inches in length, is selected, the lower end of the coil being not nearer than 8 inches from the ileo-caecal valve. The selected portion of ileum must have a mesentery sufficiently long and mobile so that after it has been prepared the distal end of the loop can be brought to lie in the right iliac fossa and pass through the stab opening in the abdominal wall without tension. The first stage of the operation consists in the preparation of the loop. The patient is placed in a moderate Trendelenburg position and the small intestine other than the loop, together with the caecum, are packed away by hot, moist swabs into the upper abdomen. A final accurate estimation can now be made of the length of the ileal loop which is required, having regard to the position of the two ureters which are to be anastomosed to it If there is any doubt as to whether the two ureters, after division, will lie without tension in relation to the ileum after anastomosis, they can be isolated and divided at this stage of the operation, but as this will leave two small, raw areas and a discharge of urine from the kidneys, it is simplest to divide the ureters after the loop has been prepared

Division of the ileum

At the lower point selected for the division of the ileum, which is usually 7 or 8 inches above the ileo-caecal valve, the vascular arcade close to the ileal wall is divided between ligatures and the resulting opening in the mesentery is extended at a right-angle to the intestine; usually a second vascular arcade has to be divided so as to give an opening in the mesentery of about 4 centimetres. A lamp held behind

the mesentery by the assistant will help in the identification of the vessels if much fat is present. A second similar opening in the mesentery is made about 14 inches above the first (Fig. 115). The base of the mesentery to the isolated loop should be as wide as possible in order to minimize the chance of rotation of the vascular pedicle. The intestine is then divided between clamps at the selected places; it is convenient to use a Cope's crushing clamp especially for the lower end of the loop since the detachable blades can be left in position after the handle of the clamp has been removed so as to facilitate the passage of the distal end of the loop through the small incision made

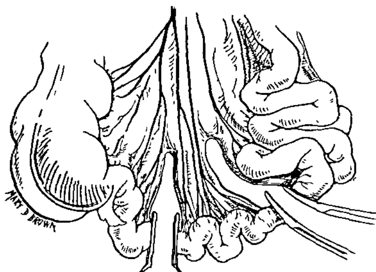


FIG 115—Isolation of the ileal loop The vascular arcades in the mesentery have been divided in order to isolate the loop, and the gut has been divided at the two selected places.

for the ileostomy at the end of the operation. Continuity of the intestine is then restored by end-to-end or lateral anastomosis, in front of the isolated loop (Fig 116). The opening between the anastomosis and the mesentery of the loop is obliterated by a few interrupted sutures between its anterior leaf and the back of the anastomosis in order to minimize the risk of a prolapse of small intestine through the opening The proximal end of the loop is closed and infolded unless it is more convenient for the surgeon to anastomose the left ureter to it.

Division of the ureters

The right ureter is mobilized through a vertical incision through the posterior peritoneum at the brim of the pelvis and divided fairly low down, the lower end being ligated. Since it is desirable to implant the ureter some 3 inches from the proximal end of the loop, the internal flap of the divided peritoneum is mobilized by passing a finger beneath it and the divided ureter is then moved nearer to the midline and in close proximity to the proposed point of its anastomosis to the ileum, by bringing it out through a small opening made with fine-pointed scissors in the posterior peritoneum.

The left ureter is similarly exposed through another vertical incision through the posterior peritoneum at the outer side of the sigmoid colon and is divided, the lower end being ligated. It is usually convenient to pass the divided upper end of the ureter through a small opening in the base of the sigmoid mesentery between the vessels so that it emerges on its inner aspect, when it will be found to lie without tension in juxtaposition with the proximal end of the loop. Sometimes the left ureter can be mobilized on the inner aspect of the meso-sigmoid. An alternative method is to allow the ileal loop to lie across the front of the sigmoid colon, joining the upper

divided end of the left ureter to the end of the loop; the disadvantage of this method is that it allows a space between the proximal end of the loop and the sigmoid colon, through which intestine may prolapse.

Anastomosis

The anastomoses of the ureters to the intestine may be made by one of the standard methods previously referred to according to the preference of the surgeon. The left ureter, having been slit up so as to give an elliptical opening, may be anastomosed directly to the end of the loop, in which case the crushing clamp should be left on the

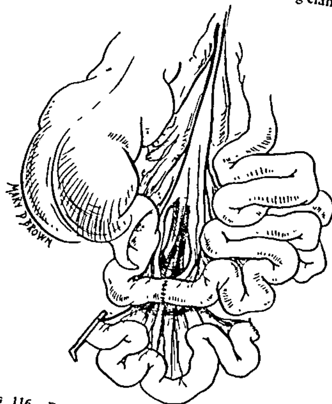


FIG 116.—End-to-end anastomosis of the intestine to restore continuity. The opening in the mesentery is later closed by stitches The proximal end of the loop is closed in most cases. Cope's clamp is left on the distal end of the loop

loop until the surgeon is ready to make the anastomosis. My own preference is to implant the two ureters into the anti-mesenteric border of the loop about 3 and 8 centimetres respectively from the proximal end. Since the ileostomy allows of free drainage of the urine into the bag any back-pressure and reflux of urine to the kidneys should be avoided. I prefer an anastomosis of the Cordonnier or Nesbit type, both of which allow of very free drainage from the kidneys and have less tendency to stricture formation at the anastomosis than the older methods; the ureters are curved round the lower aspect of the ileum and the anastomosis made in front of the loop (Fig. 117).

The Ileostomy stoma

By placing the ureteric anastomosis in the position named a sufficient length of the ileal loop is left to cross the posterior abdominal wall, to pass round the lateral wall of the right iliac fossa and for the end of the loop to be brought through a small incision in the abdominal wall in the right iliac fossa. This second incision crosses

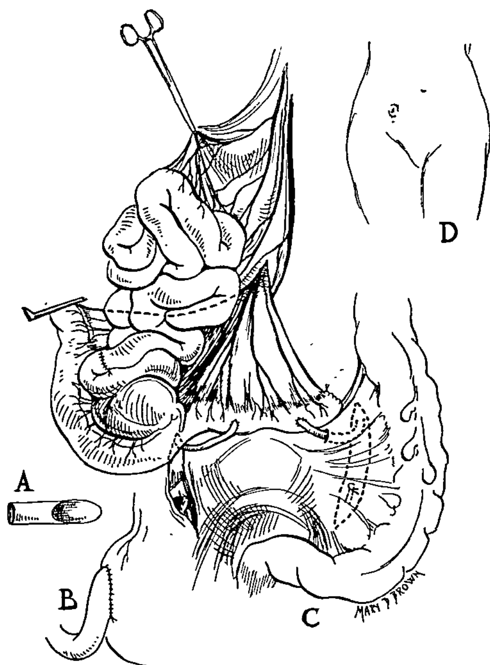


FIG. 117 —Schematic diagram to illustrate uretero-ileal anastomosis. (*A*) The stoma of the divided upper end of the ureter is cut obliquely to make an elliptical opening (*B*) Uretero-ileal anastomosis using direct mucosa-to-mucosa technique (Cordonnier's method) (*C*) Ileal bladder completed and ureters anasto-

the line between the umbilicus and the anterior superior iliac spine at the junctio of its outer and middle third, in a position convenient for the Rutzen bag to be fitte over it. The ileal loop is stitched to the posterior peritoneum and to that of the rigl iliac fossa by a number of interrupted sutures. About one inch of ileum is brougl through the abdominal wall, the clamp is removed and the end of the ileum turne inside out and sutured to the skin of the abdominal incision. The main abdomin: incision is then closed. A Foley catheter is left in the loop for the drainage of urine fo a few days after which a Rutzen bag is fitted over the ileostomy (Fig. 118).

An alternative method of dealing with the ileostomy stoma is the so-called spou

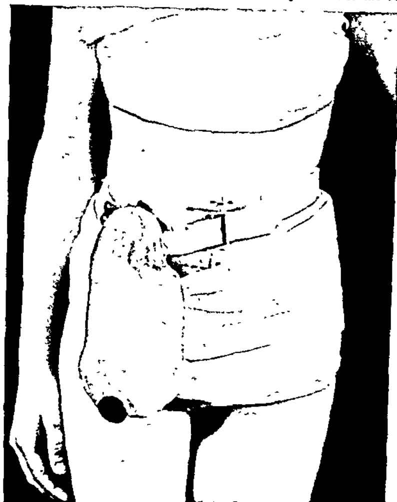


Fig. 118.—Rutzen bag in position over the ileostomy stoma in a case of ileal bladder. The operation here had been done for spina bifida with urinary incontinence.

ileostomy (Wells, 1952). The ileum is brought out of the abdominal opening for a distance of 4–5 centimetres. In order to obtain a downward draining spout the lower surface of the protruding ileum is covered with split-skin graft while the upper surface is covered with a full-thickness skin graft. After healing the graft on the lower surface undergoes sufficient contraction to cause the spout to curl downwards, which enables it to engage in the collecting apparatus.

Complications

The complications are those of the intestinal anastomosis and those of the uretero-ileal anastomoses. Post-operative ileus may be troublesome and calls for a careful watch for, and correction of, electrolyte imbalance and if necessary the use of an indwelling stomach tube and suction drainage. Peritonitis has been reported from

breakdown of the anastomosis; gangrene of the loop and obstruction of the small intestine have been reported; temporary oliguria may occur from oedema of the uretero-intestinal anastomoses though this is not usually serious. Leakage of urine at the site of the uretero-intestinal anastomosis occurred in one of our cases but lasted only for four days and cleared up spontaneously; others have reported the same complication. Acute pyelonephritis may occur but it usually responds to antibiotics; retraction of the external ileostomy stoma has occurred with secondary fistula formation (Bricker, Butcher and McAfee, 1954). If cystectomy or pelvic exenteration is performed at the same time as the construction of an ileal bladder, the operation is correspondingly more severe and the additional complications of those operations may occur.

Collection of urine

The best apparatus for collecting the urine is the Rutzen bag (Fig. 118). The end which fits over the ileostomy opening has a flange which is secured to the skin by a special cement and is re-applied each week The bag is detachable from the flanged ring secured to the skin, and a clean bag is used each day. In some patients the skin will not tolerate the adhesive cement. In an ambulant patient there is usually no



FIG. 119—Ileal bladder as a reservoir Cystogram of the artificial bladder made from a long loop of ileum The ureters have been anastomosed to the ends of the loop The middle of the loop has been anastomosed to the stump of the prostatic urethra.

leakage. At night the outlet tube at the bottom of the bag can be attached to a long rubber tube which leads to a bottle by the side of the bed.

Late results

The results of the ileal bladder operation are very satisfactory in that the patient feels and looks well, is comfortable and usually achieves urinary continence with the bag and is socially acceptable; most patients are able to return to work. In the Department of Urology at Leeds, 1 death has occurred in 10 cases The clinical results have been excellent and all the patients have been rendered continent. There has been no hyperchloraemic acidosis in any of the cases and the radiological results of the kidneys are satisfactory.

Bricker, Butcher and McAfee (1954) followed 65 patients in their series of ileal bladder for from 6 to 36 months by means of repeated intravenous pyelograms and clinical observation Of the 65 patients, 70 per cent were considered to have satisfactory results in that the pyelographic shadows of both kidneys were satisfactory and they were free of clinical evidence of pyelonephritis; 30 per cent were unsatisfactory in that they had either unsatisfactory pyelograms or clinical evidence of pyelonephritis, or both. Eighty-six per cent of the 130 renal units involved in the 65 bladder substitution procedures were either normal or showed a minimal degree of hydronephrosis 6–36 months after operation.



FIG 120 —Post-evacuation film of the ileal bladder showing a little residual urine

Annis, Hunter and Wells (1954) report the late results of ileal bladders in 15 patients for which 28 ureters were transplanted, followed up for periods of between 27 and 2 months No patients have complained of renal pain nor have they had [illegible] ascribed to renal infection. On intravenous pyelography, [illegible] 17 were normal post-operatively [illegible] which were slightly or grossly dilated or showed no function before operation, 5 showed improvement while 3 showed slightly increased hydronephrosis.

ILEAL BLADDER AS A RESERVOIR

In the operation described above the ileum has been used as a conduit for the drainage of urine. In order to combine the advantage of urinary diversion into the ileum rather than into the colon so as to eliminate or greatly reduce the chances of electrolyte imbalance, and at the same time avoid the social inconvenience of a permanent ileostomy, it has been possible in 2 cases to join the ureters to the ends of a long loop of ileum 22 inches in length and to anastomose the centre of the ileal loop to the prostatic urethra (the bladder having been removed) so as to allow micturition per vias naturales (Fig. 119) This operation has been carried out in 2 cases combined with cystectomy for carcinoma of the bladder (Pyrah, 1956). In one case the patient died from a sudden pulmonary embolism 4 weeks after an operation which was followed by an apparently normal convalescence. Autopsy showed perfectly healed



FIG 121 —Post-operative pyelogram five months after operation for ileal bladder.

anastomoses. The second case, a man aged 54 years, had multiple papillary carcinomas of the bladder which had received treatment first by perurethral diathermy and later by intravesical cavitary radium, and this was followed after an interval by radio-necrosis which resulted in persistent and severe haemorrhage. Total cystectomy was performed, removing the bladder, the seminal vesicles and the proximal two-thirds of the prostate, the latter being sectioned transversely so as to leave its distal third for anastomosis to the ileum. An ileal loop 22 inches in length was isolated and intestinal continuity was restored by end-to-end anastomosis. The ureters were anastomosed by a direct mucosa-to-mucosa technique to the ends of the ileal loop. The centre of the loop was anastomosed to the prostatic stump using two rows of sutures, securing a direct union between the mucosa of the ileum and that of the prostatic urethra. *The patient made a good recovery from the operation and is able* to micturate normally every 3 hours. When the bladder is full, he has a sensation of fullness in the lower abdomen after which urine is evacuated normally. There is a small amount of residual urine. Cystograms of the new "bladder" before and after evacuation are shown in Figs. 119 and 120. The post-operative intravenous pyelogram 5 months after operation shows no hydronephrosis (Fig 121); there is no electrolyte imbalance. The patient has been free from recurrence for 12 months and is able to work.

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PART II CRITICAL SURVEYS

HYPOTHERMIC ANAESTHESIA

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Circulatory arrest leads inevitably to oxygen lack in the tissues deprived of their blood supply; if the period of anoxia be prolonged cellular death results. The oxygen requirement of particular cells determines the duration of anoxia they can survive. Cells of the central nervous system are particularly susceptible. In the case of highly developed cells in the human brain a period of 2–4 minutes' circulatory arrest leads under usual conditions to permanent cerebral damage. For example, in cases of cardiac arrest the heart may be restarted by cardiac massage, but often, because of delay, so much brain damage has occurred that consciousness is never regained.

If the body temperature be lowered cellular metabolism and oxygen demand are reduced, so that cells may survive anoxia for longer periods. It has been shown in animals that at body temperature below 25° C the circulation to the brain may be arrested for 20 minutes and yet complete recovery may occur, there being no physiological or histological evidence of cerebral damage. At these temperatures coronary vascular occlusion was fatal, a reversal of the normal finding that the heart withstands anoxia better than the brain.

It follows from these observations that hypothermia might permit the performance of certain operations which would be impossible at normal temperatures owing to anoxic cellular death (Swan, 1954) Procedures in which a hypothermic technique might be of value are described.

CARDIOVASCULAR SURGERY

Direct repair under vision of cardiac abnormalities

This group includes intracardiac procedures (Brock, 1956) upon the open dry heart, with temporary occlusion of the venae cavae and cessation of the circulation; for example, for the repair of septal defects and certain valvular abnormalities.

Operations on the great vessels

This applies to such operations as necessitate circulatory occlusion; for example, certain operations for transposition of the great vessels.

Operations for congenital cyanotic heart disease

Although circulatory arrest is not usually essential in these cases, hypothermia reduces the oxygen demand and the anaesthetic requirements This indication for

[illegible]

advise against the technique, believing that the danger of ventricular fibrillation outweighs the slight advantage such cases may gain (Gray, 1955).

NEUROSURGERY

It is evident that hypothermia might be of advantage for intracranial procedures involving temporary arrest of the circulation to part of the brain. In this connexion it has been suggested that hypothermia might increase the margin of safety in induced hypotension for neurosurgical operations. Rosomoff (1956) has summarized the possible advantages of hypothermia in this field, and has presented convincing evidence that occlusion of the middle cerebral artery is well tolerated in experimental animals (Rosomoff, 1955) under hypothermic conditions. It might, therefore, be anticipated that hypothermia would protect against the sequelae of "retractor ischaemia" of the brain and of operations involving internal carotid artery occlusion. Hypothermia reduces brain volume: at 25° C intracranial space not occupied by brain is increased by 31·8 per cent (Rosomoff and Gilbert, 1955). The accompanying arterial hypotension may also facilitate neurosurgical procedures (Rosomoff and Holaday, 1954).

AORTIC GRAFTING PROCEDURES

In operations for aortic aneurysm involving excision and replacement by graft or plastic tube the level of circulatory occlusion is important. If this is high enough to involve ischaemia of the spinal cord, neurological damage will ensue unless the procedure be performed under hypothermic conditions. Rob and Eastcott (1955) have reported a series of such cases and the anaesthetic management has been described (Cheatle, 1955); in one centre hypotension has been induced with Arfonad during hypothermia (Julian and his colleagues, 1955).

MISCELLANEOUS PROCEDURES

Some workers have claimed that under hypothermic anaesthesia operative shock can be avoided during very radical surgery (Gray, 1955, Murray, 1955). It has also been suggested that hypotensive anaesthesia may be safer under hypothermic conditions (Dundee, Francis and Sedzimir, 1954); various therapeutic applications of induced hypothermia have been reported (Gray, 1955; Sedzimir, Jacobs and Dundee, 1955).

THE ADVANTAGES ACCRUING FROM THE HYPOTHERMIC STATE

These are discussed by Delorme (1955).

Reduced oxygen requirement

Provided shivering be prevented, the oxygen consumption falls in a linear fashion with the reduction of body temperature. At 30° C the oxygen requirement is reduced to 55 per cent and at this temperature the blood pressure is usually well maintained. At 20° C oxygen consumption is approximately 15 per cent of normal (Bigelow, Mustard and Evans, 1954) and Lynn and his colleagues (1954) suggest that it would be almost zero in dogs at 10° C

Reduced cardiac activity

Aerobic energy uptake, and to a greater degree left ventricular work, both decline (Edwards and his colleagues, 1954)

Increased coagulation time

In vitro at 20° C coagulation time is approximately trebled (Macfarlane, 1948) Under hypothermic operation conditions there may also be a fall in the number of platelets and in prothrombin formation by the liver These effects may lead to serious retardation in clotting and result in post-operative haemorrhage, but some benefit is possible, too, as thrombosis is an accepted complication of some cardiovascular operations.

Reduced anaesthetic requirements

It is reported that below 27° C consciousness is lost, the hypothermia of itself inducing the anaesthetic state.

Harmful bacterial and enzyme activity is suspended

DANGERS OF THE METHOD

The cold stress response

This is discussed by Delorme (1953). It is manifested by endocrine activity and shivering; the latter giving rise to impulses which can be observed on the electrocardiographic record. At the start of cooling there is increased sympathetic action with release of adrenaline. Vasoconstriction results and tends to retard heat loss, the efficiency of surface cooling being notably impaired. A more rapid fall of surface compared with rectal temperature is an index of this vasoconstriction, and some workers (Gray, 1955) regard this as an indication for giving a vasodilator such as chlorpromazine. During cooling there is increased production of ACTH and of thyrotropic hormone which tends to raise heat production; even in the absence of shivering some initial rise in oxygen consumption is possible, especially with surface cooling.

The muscular activity involved in shivering leads to an increase in heat production and oxygen demand; this process can for a time prevent a fall in temperature in the initial stages of the cooling procedure. Shivering can and should be prevented by anaesthetics, by muscle relaxants, and by chlorpromazine. This last agent is particularly effective in helping to lower body temperature, which it does by decreasing heat production in voluntary muscle, by producing vasodilatation and so promoting heat loss and, possibly, by an effect on the temperature-regulating centre. In addition to these effects chlorpromazine has a wide range of pharmacological activity. It is not essential to the hypothermic technique.

Tissue injury due to cold

In surface cooling methods tissue injury can be prevented by avoiding extreme degrees of cold. It is unfortunate that infants are especially liable to subcutaneous fat necrosis under these conditions because infant fat has a relatively higher melting point (Collins, Stahlman and Scott, 1953). Precautions must also be taken to avoid thermal damage during rewarming.

Effects on vital organs

Certain histopathological changes in vital organs (liver, kidneys, adrenals) have recently been reported in dogs subjected to hypothermia (Knocker, 1955). These results have not been confirmed elsewhere and the significance of the changes remains to be assessed, it must be pointed out that certain features of the anaesthetic and cooling methods employed in this work, and especially the prevalence of untreated respiratory depression, are not in accord with clinical practice. An increasing number of successful cases operated upon during hypothermia implies that damage to vital organs does not constitute a serious objection, and post-mortem findings in fatal human cases do not support the histological findings quoted above Brewin, Nashat and Neil (1956) have recently reported that in animals under hypothermia circulatory arrest for 10 minutes produces a severe derangement of liver function and structure; on rewarming, liver function is not improved. These effects may be caused by the marked rise in central venous pressure due to the circulatory occlusion: if this rise in venous pressure be prevented, the liver damage may be avoided and the function on rewarming is then apparently normal. With regard to the brain, there is electroencephalographic depression during hypothermia, but there is ample evidence that the changes are reversible and that cerebral function is unimpaired on recovery (Callaghan and his colleagues, 1954).

Changes in the blood

Alterations in acid-base equilibrium

At low temperatures the carrying power of the blood for carbon dioxide is increased owing to reduced ionization of haemoglobin and protein. The solubility of carbon dioxide in blood is increased at lowered temperatures, but this does not lead to a gaseous acidosis because its effect on *p*H is offset by the increased bicarbonate carriage.

Respiratory activity diminishes as the temperature falls and as a result carbon dioxide retention occurs; the resulting fall in *p*H may be in part the cause of ventricular fibrillation. This gaseous acidosis can be prevented by hyperventilation, which should therefore always be performed during hypothermia. With hyperventilation the blood pressure (and so presumably coronary flow) is better maintained as the temperature falls and, experimentally, survival to lower temperatures is possible before cardiac arrest occurs (Lynn and his colleagues, 1954). It is possible that positive/negative pressure ventilation is advantageous during hypothermia because, in addition to efficient hyperventilation being secured, a rise in venous pressure is prevented.

A metabolic acidosis also occurs during hypothermia (Brewin, Nashat and Neil, 1956); this is associated with a raised blood lactate concentration and is especially severe in cases subjected to circulatory arrest. The causes include generalized circulatory insufficiency and an impaired ability of the liver to metabolize lactate: derangement of the liver function has already been noted. Brewin and his colleagues suggest that this metabolic acidosis can be treated by intravenous administration of a calculated dose of sodium bicarbonate.

Increased viscosity

Increased viscosity occurs in the first place as a simple physical effect of cooling the blood, and secondly as a result of the haemoconcentration which accompanies the induction of hypothermia. In cases of congenital cyanotic heart disease the blood is already very viscous—the haemoglobin may be 140 per cent—and this effect is especially undesirable. Coupled with the vasoconstriction which accompanies cooling, the increased viscosity leads to elevation of the peripheral vascular resistance, so adding to the work of the heart.

Impaired coagulation

This may lead to serious post-operative haemorrhage; the causation has already been outlined

Oxyhaemoglobin dissociation

At low temperatures oxyhaemoglobin dissociates at relatively lower partial pressures so that, theoretically, it is harder for the tissues to obtain oxygen. This effect may be offset by reduced tissue oxygen demand and would be mitigated by any alteration in *p*H towards the acid side.

Electrolyte changes

The interrelation between carbon dioxide carriage and ionic equilibrium in the blood has already been mentioned. Varying effects during cooling on sodium, potassium and other ions have been reported, possibly depending on the adequacy or otherwise of ventilation during the observations. Churchill-Davidson (1955) reviews these reports and mentions a rise in plasma calcium levels at temperatures below 25° C, which may effect the heart.

The elimination of non-volatile anaesthetic agents

The elimination of non-volatile anaesthetic agents is greatly retarded, presumably in association with the reduction in metabolism. There is a linear fall in renal blood flow and excretion as the temperature falls (Churchill-Davidson, 1955).

As already noted, anaesthetic requirements are reduced in the hypothermic state: consciousness is lost at about 27° C and respiratory arrest may occur at 23–25° C. Barbiturates and other respiratory depressants will predispose to respiratory arrest at relatively higher temperature levels. Because of these considerations, drugs such as thiopentone and pethidine should be used in minute amounts and the dose of post-operative sedatives should be reduced.

The reaction to relaxants may be altered by profound changes in body temperature (Quilliam and Taylor, 1947; Dripps, 1955). during hypothermia the action of depolarizing agents is enhanced and prolonged, whereas the effects of those relaxants producing non-depolarization block are somewhat antagonized (Zaimis, E. J., personal communication). The observation of Brown (1954) that acetylcholine secretion at the synapse is depressed may be of importance in this connexion.

The metabolism of glucose, also, is retarded during hypothermia. Wynn (1954) has reported a blood glucose level of over 1,000 milligrams per 100 millilitres during hypothermic anaesthesia; there was a concomitant serious fall in plasma electrolytes. For this reason a glucose solution should be used very sparingly, if at all, for the intravenous drip.

Cardiovascular system

As body temperature falls the heart rate, cardiac output and arterial blood pressure all decrease. For example, in dogs at 20° C the cardiac output may be only 15 per cent of normal. In proportion, the arterial pressure falls less than the other two factors The mean arterial pressure is the product of the cardiac output and the peripheral resistance and, although the cardiac output falls with the temperature, the peripheral resistance is increased, as already noted. As a result the arterial pressure may fall only slightly until 30° C or less, but it may drop sharply in the region of 25° C. In contrast the venous pressure may rise during hypothermia, this effect being mitigated when positive/negative pressure ventilation is employed. During the period of circulatory arrest the central venous pressure may be greatly elevated; Brewin, Nashat and Neil (1956) suggest that this may be the cause of liver damage· measures to prevent this venous congestion are described and these are capable of alleviating the effects on the liver. Gray (1955) reports that during hypothermia in adult dogs the cardiac output is not maintained at high venous flows, that is, Starling's law no longer applies. The coronary flow falls to a greater extent than the blood pressure, the implication being an increase in the ratio of cardiac work to coronary flow. After initial acceleration when cooling begins the heart rate decreases in a regular and linear fashion as the temperature is reduced; at temperatures below 25° C in man ventricular fibrillation may occur abruptly. The pulse shows a linear fall in rate, which is not abolished by vagal paralysis and is therefore presumed to be due to a direct effect on the pacemaker. A bradycardia of 30 per minute is common during operations under hypothermia, the process of cardiac contraction is slowed; typical electrocardiographic changes are shown in Fig. 122 As the temperature falls to critical levels extreme bradycardia (Cookson, Neptune and Bailey, 1952) or cardiac irregularities may occur; therefore electrocardiographic control is essential throughout these procedures. Cardiac irritability appears to be increased and direct surgical stimulation of the heart may provoke ventricular fibrillation (Lynn and his colleagues, 1954; Swan, 1954)

As further cooling takes place spontaneous ventricular fibrillation or cardiac standstill occurs and may cause death in progressive hypothermia. Dogs appear more liable to this event than human beings; in fact there is a great species variation in the temperature level at which this complication is encountered; in rats it may not happen until 12° C or lower (*Lancet*, 1954), but in adult man it is likely to occur in the region of 25° C. Fortunately infants and young children are more resistant than adults in this respect, and it is in such young patients that the method has so far

found its most frequent application. In those with acquired heart disease (for example, previous rheumatic carditis) the liability to ventricular fibrillation is said to be increased and the method is regarded by some as contra-indicated in such patients (Bailey and his colleagues, 1954; Gray, 1955).

The exact cause of ventricular fibrillation during hypothermia is imperfectly understood. Lange, Weiner and Gold (1949) blamed anoxia and reported amelioration with high oxygen tension: these findings have not been confirmed. Other workers blamed the reduced coronary blood flow, measures designed to improve it having a protective effect (Ross, 1954a). The remarkable revival of heart beat in the cadaver by coronary perfusion reported by Kountz (1936) is of interest in this connexion. Others suggest that the fall in *p*H is responsible (Fleming, 1954) and it has been observed that hyperventilation has a preventive influence (Swan and his colleagues, 1953; Lynn and his colleagues, 1954; Fleming, 1954). There have also been reports

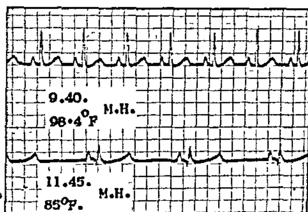


FIG. 122 —E.C.G lead 2: bradycardia at 85° F.
(By courtesy of the Editor of the "Proceedings of the Royal Society of Medicine")

that a sudden fall in an abnormally high blood carbon dioxide level can precipitate fibrillation in the dog (Miller and his colleagues, 1952; Swan and his colleagues, 1953). Electrolyte changes may be implicated, but the evidence is contradictory. Sealy, Young and Harris (1954) noted that post-hypercapnic fibrillation is associated with increased serum potassium—improvement resulted from giving sodium and glucose By contrast, Swan and his colleagues (1953) and Zeavin, Virtue and Swan (1954) reported a fall in serum potassium during cooling and used potassium chloride [illegible] potassium [illegible] rris, 1954). [illegible] Melrose and his colleagues (1955) have [illegible] a technique [illegible] circulation with potassium [illegible] potassium concentration and the heart beat recommences.

Some workers (McMillan and his colleagues, 1955) have observed a rise in plasma calcium levels below 25° C, the calcium/potassium ratio being increased. Melrose (cited by Churchill-Davidson, 1955) produced evidence that this increase in ionized calcium could produce a current of injury potential in the electrocardiogram; such a change in the region of the S wave appeared to be a precursor of ventricular fibrillation. Conversely, Swan and his colleagues (1953) have used calcium chloride successfully to treat cardiac arrest in a hypothermic patient. Another suggested factor is that during hypothermia acetylcholine production is depressed (Brown, 1954), so that, the pacemaker losing its dominance, ectopic foci tend to arise. In keeping with this, Swan (1954) and Prevedel, Montgomery and Swan (1954) reported that prostigmine introduced into the coronary circulation had a powerful protective effect against

fibrillation; Delorme (1955) has published records showing inhibition of cardiac activity by prostigmine with abolition of its effect by atropine in the hypothermic dog.

It is of interest to note that hibernating animals can be cooled to 4° C (Juvenelle, 1954; Burton and Edholm, 1955), a temperature which in the non-hibernator would certainly lead to ventricular fibrillation; Smith (1954) has reported revival of golden hamsters from body temperatures below 0° C. As previously stated, infants and young animals withstand cooling much better than adults. From these considerations it seems likely that the basic cause of fibrillation is connected with the qualities of inherent cardiac rhythmicity and conductivity. It is possible that drugs may be developed (Cookson, Neptune and Bailey, 1952; Sealy, Young and Harris, 1954) which will prevent this complication arising; Cookson (1956) states that certain quaternary compounds increase the liability to it.

Should ventricular fibrillation occur, repair of the cardiac defect is immediately performed if the operation has progressed sufficiently. Cardiac massage is then undertaken and when the heart muscle is seen to be well-oxygenated and its tone has increased, defibrillation is attempted by means of repeated brief electrical shocks of 1·5–2·0 amps. Brewin (1954) has advocated the injection of 1 millilitre of 1 : 3,000 adrenaline into the ventricular cavity, followed by massage, when cardiac tone improved a single one-fifth second shock of 1 amp. was given: after a short interval a co-ordinated beat reappeared.

Potassium and calcium solutions have also been employed with success, Swan using potassium chloride to arrest fibrillation and following with calcium chloride to restart the heart On occasion an electrical artificial pacemaker may be useful.

After-cooling

Despite the cessation of cooling the temperature of the subject continues to fall for 30 minutes or more, depending on the physique of the patient. If this is not anticipated, the desired level may be overshot (Scurr, 1955) This drift is probably more marked after rapid cooling by immersion in a bath. Gray (1955) advises changing the patient's position every 15 minutes during surface cooling in order to lessen the pooling of cooled blood in any one part of the body, with the aim of reducing the extent of the after-drop. In the rewarming period "after-cooling" may occur, this is presumably due to opening up of the circulation in the very cold outer shell of the body (Burton and Edholm, 1955), very cold blood from the periphery thus entering the main circulation. This further fall in central temperature may lead to fatal ventricular fibrillation. It is obvious that the danger of this after-drop will be greater in methods involving surface cooling than in extra-corporeal cooling of circulating blood.

The fact that temperature gradients can be set up in the body raises the question of the best site at which to assess the body temperature. Many workers have hitherto observed the rectal temperature by means of a thermocouple; there is ample evidence that this does not provide an accurate guide to the central body temperature (Gerbrandy, Snell and Cranston, 1954). It is obvious that the cardiac temperature is of the greatest importance and pharyngeal or oesophageal temperatures are more reliable guides to the degree of cooling. A thermocouple for the brain has recently been devised.

Limit of time available

The studies on the heart imply that at the present time 25° C is the lowest temperature that can be induced with relative safety. This factor limits the time available for circulatory arrest if anoxic sequelae are to be avoided, and Bigelow, Mustard and Evans (1954) have tabulated the period of circulatory interruption and the concomitant body temperature likely to be required for various procedures. Brock (1956)

accepts a limit of 10 minutes arrest at 28° C. Bailey and his colleagues (1954) have reported a case of complete circulatory interruption in an infant for 22 minutes at 21·6° C: there was no evidence of cerebral damage 30 hours after operation. Rob (1955) has described an operation under hypothermia in which occlusion of the thoracic aorta for 2 hours was followed by definite but minimal signs of cord damage.

It is thus seen that the usefulness of hypothermia in the direct repair of cardiac defects is limited by the short period of time which it affords for the procedure; this technique is thus likely to be supplanted when a successful pump-oxygenerator is developed to permit of cardiac by-pass.

METHODS OF INDUCING HYPOTHERMIA

Surface cooling

The patient may be immersed in a bath of cold water (Virtue, 1955) or ice packs applied to the surface of the body (Gray, 1955). In other centres a special cooling blanket is used to cover the patient; water at a temperature of 2–4° C is circulated by means of a pump through tubes incorporated in the blanket (Inglis, Biffen and d'Abreu, 1954; Scurr, 1955). The apparatus used is shown in Fig. 123. The patient is anaesthetized and intubated in the usual way and then placed on the cooling blanket. The electrocardiographic leads are attached and an intravenous drip is set up. Instruments for observing the body temperature are inserted into the pharynx or oesophagus, and the rectum (the unreliability of the latter site has been noted). A mercury-in-glass or, more conveniently, a long mercury-in-steel thermometer may be used. Alternatively, a thermocouple or resistance thermometer may be chosen. Whatever

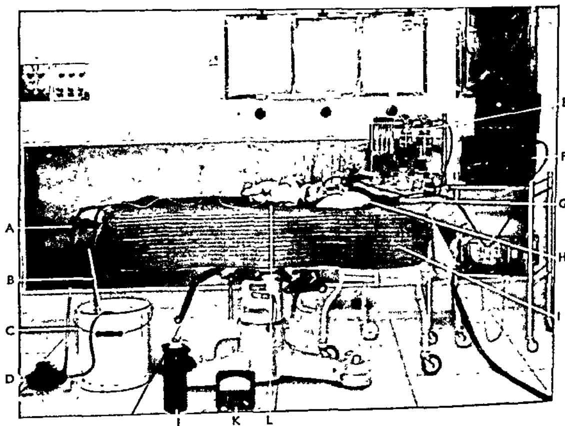


Fig. 123.—Apparatus for hypothermic anaesthesia. A.—Blanket inflow. B.—Outflow thermometer. C.—Reservoir. D.—Pump. E.—Anaesthetic machine. F.—E.C.G. apparatus. G.—Breathing bag. H.—Carbon dioxide absorber. I.—"Freezing blanket". J.—Zero junction. K.—Galvanometer, and L.—Rectal junction: thermocouple.

(By courtesy of the Editor of the "Proceedings of the Royal Society of Medicine".)

instrument is selected, it must be carefully calibrated against a standard thermometer, as errors in temperature level may have serious consequences. Ordinary clinical thermometers are inadequate in range.

The blanket is closed and the circulation of cooling fluid is continued. Light anaesthesia is maintained, for example with cyclopropane or ether and oxygen, or thiopentone, nitrous oxide and oxygen, with a relaxant so as to prevent shivering. The assistance that chlorpromazine affords to cooling has already been pointed out. At 27° C the anaesthetic may be discontinued and 100 per cent oxygen used for the inflation; shortly afterwards the operation is begun, relaxants being given as necessary

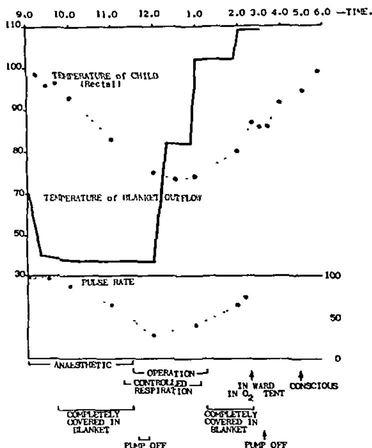


FIG 124 —Chart of Blalock's operation on child aged 5 years
(By courtesy of the Editor of the "Proceedings of the Royal Society of Medicine")

during the thoracotomy. At the start of cooling there is usually some apparent increase in respiratory activity. Later, respiratory depression occurs—the temperature of respiratory arrest varies, being higher in proportion to the previous administration of respiratory depressant drugs During cooling adequate controlled respiration should be started as soon as respiratory depression becomes evident. During emergence respiratory activity usually returns at a lower temperature level than that of apnoea during cooling. It is worth noting that the pupils are widely dilated throughout the hypothermic period The temperature variations are shown in Fig. 124, which records the course of a Blalock's operation on a child aged 5 years.

Surface cooling methods are slower in action and liable to the dangers of cold injury, of shivering and the development of thermal gradients and overshoot; it is also probable that metabolic changes and haemoconcentration are more marked. The technique is, however, simple and avoids cannulating an artery with the attendant

threat to a limb. In small infants the cannulation may be a difficult undertaking and in such cases surface cooling may be preferable.

After the cardiac procedure is completed *rewarming is allowed to occur*; in some centres (Scurr, 1955) warm water is circulated through the blanket. An alternative is to immerse the patient in warm water after the chest has been closed. Other workers prefer merely to cover the patient with warm blankets and allow the patient to rewarm slowly; it seems desirable, however, to elevate the body temperature above the danger zone as rapidly as possible—once 30° C has been attained the patient may be returned to bed. Rapid rewarming has dangers of its own; a serious after-drop is a possibility, widespread vasodilatation may lead to circulatory collapse, and thermal damage may result from over-zealous rewarming. The short-wave diathermy can be used to promote rewarming (Virtue, 1955) but, again, care must be taken to avoid burning.

Body cavity cooling

This method is akin to surface cooling; it has been briefly reviewed by Delorme (1955).

Extra-corporeal bloodstream cooling

This involves circulating blood from an artery (for example, the subclavian or femoral) through a length of plastic tube immersed in a cooling mixture and returning the blood into a vein (saphenous) (Delorme, 1952). In other centres, a vein-to-vein circulation incorporating a pump has been used (Ross, 1954b). Extra-corporeal cooling is more rapid and also saves time by enabling cooling to proceed *pari-passu* with the opening of the chest or even after the chest has been entered and the diagnosis established by examination of the heart (the procedure being safer on the normothermic heart—fibrillation may be provoked during hypothermia). In view of the metabolic changes which have been enumerated it is highly desirable to reduce the cooling period to the minimum in this way. An additional advantage of this plan is that cardiac massage is immediately possible if cardiac arrest or fibrillation occur: furthermore, rewarming of the circulating blood is feasible and leads to early elevation of cardiac temperature.

Arteriovenous cooling

This [illegible] (1951)
and by [illegible]
Briefly, [illegible]
which is immersed in circulating ice-water. The smooth, non-wettable surface obviates the need for anticoagulants. The cooling coil functions as an arteriovenous shunt and thus imposes an extra load on a pathological heart. In spite of excision of the damaged segment, arterial thrombosis might follow this procedure. As the cardiac output falls with the temperature the flow through the coil diminishes, resulting in progressive slowing of the cooling process Physical calculation of the number of calories of heat to be removed to produce a stated temperature drop in a subject of given body-weight gives an impressive figure, which is a guide to the magnitude of the problem of heat abstraction in this manner.

Venous cooling

Some of the disadvantages of arteriovenous cooling have been overcome in the method devised by Ross (1954b). As originally applied, blood is sucked from a a catheter in the superior vena cava, pumped through the cooling coil and returned to the inferior vena cava. A simple hand-driven rotary pump is used. In the latest form of venous cooling, after opening the chest both cannulae are introduced through the right atrium into the venae cavae; Brock and Ross (1955) give an excellent and

detailed description of the technique. They point out that venous rewarming is possible by inserting fresh cannulae through the right atrial appendage and pumping blood through the coil, which is immersed in warm water at 40° C; surface rewarming is used in addition.

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PARTIAL NEPHRECTOMY

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HISTORY

Partial nephrectomy became recognized as a possible procedure in the treatment of localized renal disease during the latter part of the nineteenth century, but it soon fell into disrepute because of numerous failures, due partly to faulty surgical technique, partly to inaccurate or incorrect diagnosis and a wrong selection of cases With the advent of x-ray and new and thorough methods of urological diagnosis, this operation has steadily become more popular and in recent years, as a result of better understanding of the basic principles involved, has become recognized as the best method of treating certain diseases of the kidney

DEFINITION

The term partial nephrectomy means the removal of a portion of a kidney, usually a single pole, occasionally both poles, and rarely the central part alone or in combination with a pole. At least one-third of the kidney must be retained and must be capable of functioning satisfactorily. The part thus removed may contain part of the pelvi-calyceal system, or may consist solely of renal cortex, as for example after excision of a solitary cyst Calycectomy or calycine resection and papillectomy are included in the general term partial nephrectomy

Partial nephrectomy must not be confused with heminephrectomy which implies the removal of one complete unit, for example "half" of a congenitally anomalous double kidney or of a horse-shoe kidney

The operation is performed by the excision of a wedge or by straight section In the treatment of calculi the operation should be performed with the axis of section placed as depicted in Fig 125*a* All the minor calyces of a pole can then be removed and if the surgeon desires when the operation is performed on the lower pole, the incision can be enlarged medially into the pelvis to permit extraction of pelvic calculi

INDICATIONS

Localized renal calculi

Aetiology of primary renal stone

In order to understand the basic principles involved in the treatment of primary renal calculi by partial nephrectomy, the surgeon should be acquainted with the recent views on the aetiology of calculi.

Stones in the kidney can be divided into two groups. (1) primary; and (2) secondary The primary stones originate in the renal cortex, the secondary ones in the pelvi-calyceal system as a result of stasis, infection and the like.

Primary stones.—Although it is wise at this stage of our knowledge to classify primary stones from the aetiological point of view into two groups, it is not unlikely that the fundamental explanation of both groups may lie in the lymphatic theory of causation.

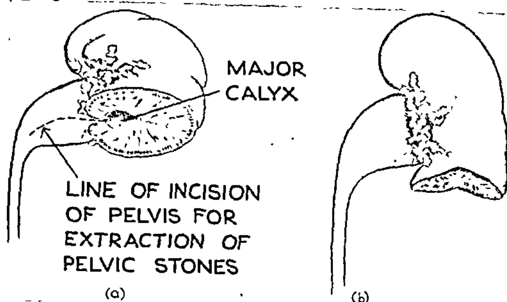


FIG 125(*a*) and (*b*).—Wedge or cuneiform resection of the kidney.

Randall's stones (1937) which form on calcified plaques on a papilla (Fig 126*a*, *b*, and *c*) Calcareous material deposited beneath the epithelium and between the collecting tubules causes atrophy and destruction of the epithelium; the calcareous material becomes bathed in urine, and deposition of further salts occurs on the exposed surface and a stone develops which at first is adherent to the papilla.

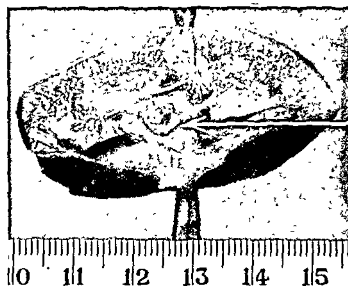
Carr's stones (1954) form from small calcified bodies he called "concretions" which occur singly or in small clusters just outside the fornices of the calyces (Fig. 127*a* and *b*). The cavities in which they lie are separated from the fornices by only a thin membrane and he considered that these small cavities or "pouches" were dilated lymph vessels. This dividing membrane can rupture completely and allow the concretions to escape but if the rupture is incomplete, urine can leak into the pouch and urinary salts are then deposited around these concretions They may thus be held together and form a single stone with multiple concretions as the nucleus, or a single concretion may grow into a stone.* Anderson (1946) and Carr (1954) also showed that deeper in the kidney substance of the involved segment were similar but smaller calcified bodies or microliths. Carr postulated that any intrarenal calcific deposits or other debris, within or without the tubules, were removed *via* the lymphatics and that stones form as a result of a breakdown in this mechanism. In the ordinary run of cases of primary renal stone, this breakdown is probably due to a fibrosis from previous inflammation, and usually only a single segment of the kidney is involved. In general metabolic diseases, and in primary tubular defects, calcific deposits occur usually throughout both kidneys, and it seems likely that in such cases the whole lymphatic drainage mechanism breaks down on account of being overloaded. In such cases, tubular calcification may be prominent as is shown in Fig 128

A primary stone having developed in the way described may remain in the calyx and gradually increase in size. It may enlarge through the neck of the calyx into the pelvis and in due time a staghorn calculus may result. It may on the other hand mature in the calyx and later be extruded into the pelvis and increase in size there if it is not passed down the ureter. Alternatively, the primary stone or stones may pass down the urinary tract and if they are large enough, renal colic will result. If the

* Occurrence of stones with multiple spherical bodies as a nucleus has now been confirmed by Prien (1955), who concurs that Randall's theory (1937) cannot explain them.



(*a*)



(*b*)



(*c*)

FIG. 126—(*a*) Calculus adherent to Randall's plaque; (*b*) Randall's plaque after removal of calculus; (*c*) microradiograph of Randall's plaque.



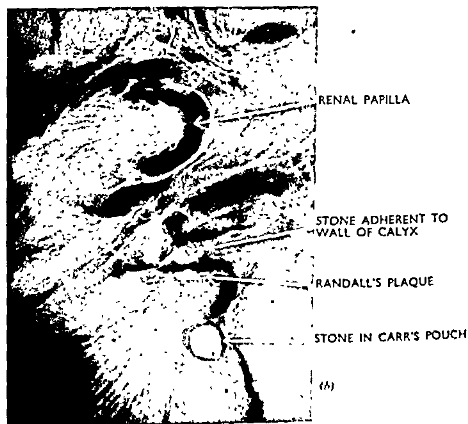


FIG 127.—(*a*) Stone lying in Carr's pouch (*b*) Microradiograph showing early stone formation

By courtesy of Dr R J Carr)
(These two photographs are also by courtesy of the Editor of the British Journal of Urology.)



(a)



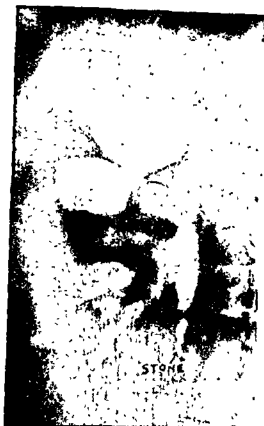
(b)

FIG 128 —(a) Tubular calcification and calculus in pelvis of kidney (b) Nephrocalcinosis

(By courtesy of the Editor of the British Journal of Urology)



(a)

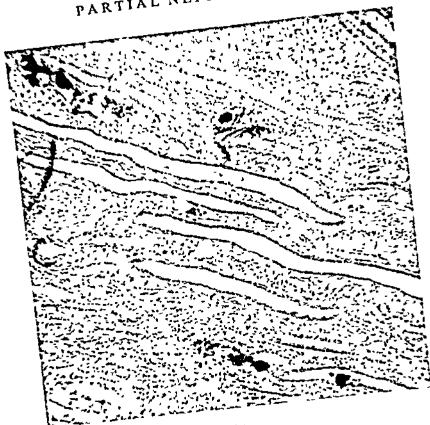


(b)



(c)

FIG. 129.—(*a*) Hydrocalyx due to calculus impacted in neck of a major calyx (*b*) Hydrocalycosis affecting minor calyces of upper pole due to impaction of a calculus in the major calyx At the time of x-ray examination the stone had passed down into the upper ureter (*c*) An infected right upper calyx containing granulation tissue—this calyx previously contained a calculus—*condition responsible for persistence of urinary infection*



(a)



(b)

FIG. 130 —(a) Microliths in the interstitial tissue—no surrounding inflammatory reaction. (b) Squamous metaplasia.

stone is a Randall's stone then the calcareous material on the papilla may be carried off with it and healing of the papilla may later result. In the case of a Carr's stone, the pouch may be emptied of its concretions and may now become part of the calyceal system. It is evident, however, in both cases, that calcareous material may be left behind and serve as a basis for further stone formation. Moreover, the segment of the kidney which is stone forming and pathological remains, and further stones may thus develop many years later. It is thus clear that in the surgical treatment of primary stone in the kidney the affected segment or segments should be removed if recurrence is to be avoided.

Pathological changes in the kidney

The gross pathological changes in the renal tissue are principally dependent either upon the degree of obstruction caused by the calculus to the outflow of urine, or on anatomical or intrinsic pathological changes in the calyx and its infundibulum. The calyx becomes dilated and a gradation occurs between caliectasis and hydrocalycosis. In the latter condition the calyx may be transformed into a cyst which, on occasions, may become very large. If the calculus is impacted in the major calyx, the minor calyces may be grossly dilated. A small opening, however, can usually be found communicating with a major calyx or the pelvis. Fig 129*a* and *b* depicts these appearances.

The dilated calyx or calyces in some cases become infected, either from the blood stream or, less often, from an ascending infection from the lower urinary tract. Ureteric catheterization carried out with faulty technique or on unsuitable cases may have the same result When infected, the calycine cavity contains purulent urine and inflammatory changes are seen in the surrounding kidney tissue. This focus of infection is one of the causes of recurrent urinary tract infection, and until it has been removed permanent sterilization of the urinary tract, even by the use of antibiotics, is very unlikely to be achieved. Although a calycine calculus may pass down the urinary tract, infection may persist in the dilated pathological calyx which remains. Pyelograms of such a case (Fig. 129*c*) are shown in which a subsequent nephrectomy was performed and infection demonstrated by pathological examination.

Microscopic examinations of specimens removed by partial nephrectomy for the treatment of renal calculi were carried out. The microphotographs (Fig. 130*a* and *b*) show microliths and squamous metaplasia. Microliths were found in 75·8 per cent of the specimens examined, and were present in the interstitial tissue without any surrounding inflammatory reaction. Some of them were seen to project into the collecting tubules. Squamous metaplasia of the pelvi-calyceal lining was seen in 23 3 per cent of the specimens. This change may be due to mechanical irritation from the stones, or to vitamin A deficiency, but the aetiology has not been determined with certainty.

Microradiography and diffraction analysis

Carr examined by microradiography many of these specimens, and also kidneys obtained from the post-mortem room. He observed the presence of microliths and also larger calcified bodies which he called concretions lying in pouches in relation to the fornices of the calyces. He postulated that these calcified bodies were located in the lymphatics. He showed that in any one case the microliths, concretions and the primary stone in the pelvi-calyceal system were composed of the same substance. He moreover demonstrated the presence of the same substance in bodies located in the peripelvic fat. Fig. 131, which was made by Dr Carr, illustrates a stone removed by the author.

Observations on partial nephrectomy in the treatment of renal calculi

The author observed before 1938, as a result of repeated skiagrams taken over a prolonged period of time, that recurrent primary stones matured in the same part

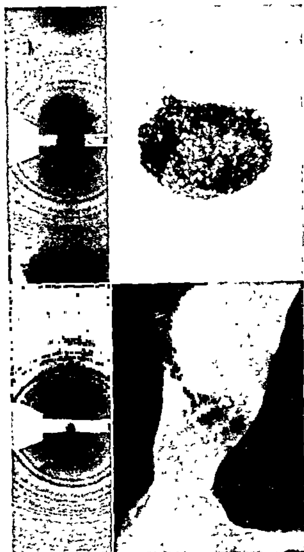


FIG. 131.—Top right shows a large stone from the kidney of a girl aged 20 years. Bottom right is a micro-radiograph of a piece of fatty tissue containing a concretion from outside the pelvis of this kidney. On the left are the diffraction patterns of each, showing that they are identical substances.
(By courtesy of Dr R J Carr and the Editor of the British Journal of Urology)

of the kidney, usually in the lowest minor calyx. As a result of this observation he carried out a series of partial nephrectomies and the affected calyx and calyces were removed

The cases were followed up radiographically in 1952, and then again a final series was investigated in 1955 The recurrence rate following 152 partial nephrectomies observed over a period of 16 years was 7·9 per cent. A study of the recurrent cases revealed that in all but one, the recurrence had occurred in the lower pole and was located in a minor calyx or in the truncated major calyx which had not been removed at the time of the partial nephrectomy (Fig 132).

It thus appeared that if recurrence of a primary calculus were to be prevented then the major calyx with all its associated minor calyces must be removed in a lower polar partial nephrectomy. The removal of a minor calyx alone was insufficient to prevent recurrence (Hamilton Stewart, 1952, 1953, 1955)

Site of election of stone formation in the kidney

Table I gives the position of the primary calculi in the kidney. Stones were passed or were removed from the same urinary tract prior to partial nephrectomy in 26·9 per cent of the cases in Table I. Five of these cases formed recurrent stones after partial nephrectomy.

TABLE I

POSITION OF PRIMARY CALCULI IN THE KIDNEY

Position	*Number of partial nephrectomies*	*Percentage*
Lower pole	111	73
Upper pole	29	19
Upper and lower poles	5	3 2
Upper pole and middle calyx	1	0 6
Lower pole and middle calyx	6	3·9
Total	152*	

* Performed on 144 patients

Eight patients [illegible] lower pole of e[illegible] kidney; and 1 w[illegible]

Sex incidence male = 96, female = 56.

TABLE II

RECURRENCE OF STONE FOLLOWING PARTIAL NEPHRECTOMY

Period of follow-up (years)	*Number of partial nephrectomies*	*Recurrences*	*Site of recurrence*
16	1		
15	1		
14	1		
13	1		
12	4	1	Lower pole
11	9	2	Lower pole
10	9		
9	3		
8	9	1	Upper pole*
7	6	1	Lower pole
6	9		
5	13	3	Lower pole
4†	13	2	Lower pole
3	15	1	Lower pole
2	12		
1	16		
Less than 12 months	17		
Total	139‡	11	

Recurrence rate was 7 9 per cent

* A recurrence was not noted in the follow-up of 1952

† One case died from acute leukaemia and *post mortem* showed no recurrence.

‡ For various reasons, for example, death from other causes, it was possible to follow-up only 139 out of the 152 partial nephrectomies

The following deductions can be made from the figures shown in Tables I and II.

The majority of calculi form in the lower pole of a kidney—73 per cent in the lower pole alone. If several segments are stone-forming, then in over 80 per cent of these kidneys stones will be found in the lower pole as well as in other parts

If the lowest minor calyx of a kidney alone is removed for stone then there is a

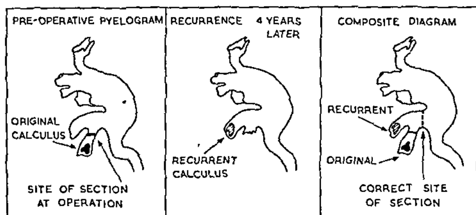


FIG. 132 —Tracings of pyelograms of a case of recurrent calculus after incomplete lower polar partial nephrectomy.

(By courtesy of the Editor of the British Journal of Urology)

risk that a further stone will form in the other minor calyx (or calyces) of the lower pole which remains. To reduce the risk of recurrence the whole lower pole with its major and minor calyces must be removed, a segmental resection thus being performed.

In the upper pole the risk of recurrence after removal of a minor calyx alone is much less than in the lower pole. If conservation of renal tissue is absolutely essential, then an incomplete upper polar partial nephrectomy (calycectomy) is justifiable.

Segmental resection

A possible explanation of the fact that the whole lower pole must be removed (segmental resection) if recurrence of primary stone is to be avoided, may be found in the anatomy of the lymphatic drainage system of the kidney (Kaiserling and Soostmeyer, 1939; Pierce, 1944, Rawson, 1949; Babics, 1951; and Lowgren, 1955). Connecting lymphatics from the renal cortex and the medulla join in the cortico-medullary zone into larger lymphatics, into which vessels drain from the pyramids. These larger lymphatic trunks travel along with the interlobar vessels towards the sinus renalis Lymphatic trunks from the pelvis and the proximal ureter also enter the sinus. The lymph from these lymphatics is drained away by four to eight larger lymphatic trunks which leave the kidney through the hilum taking their course along the main branches of the renal vessels to the lymphatic glands.

Graves (1954) has recently shown that the arterial supply of the whole lower pole comes from a single branch of the renal artery It is therefore likely that the whole lower pole is drained by a single lymph trunk and skiagrams taken after pyelolymphatic backflow tend to confirm this view (Fig. 133) Defective drainage in this lymphatic trunk would therefore impede the drainage of lymph from the whole lower pole Thus, if Carr's theory is correct, concretions would collect in the lymphatic pathways of the whole pole and stones would be liable to form in all the minor calyces

When skiagrams are taken of the exposed kidney, and stones are present in the lowest minor calyx, calcium concretions can often be seen related to other minor calyces in this pole. This explains why the surgeon should remove the whole lower pole and not just the stone-containing minor calyx. The recurrences in the series described confirm that this is necessary. It also explains why simple removal of the stone is so frequently followed by recurrence. In the upper pole, Graves has shown that the arterial supply is from several vessels and we have evidence that each of the superior minor calyces has its own lymph vessel (Fig 134). It is therefore permissible to do a simple removal of a stone-bearing minor calyx in the upper pole without



(a)



(b)

FIG 133—(a) Pyelogram and (b) tracing to show lymphatic vessel draining lower pole.
(By courtesy of the Editor of the British Journal of Urology)

much risk of recurrence. The author had only one recurrence from this procedure in this pole.

Factors which encourage the retention of small calculi in a terminal calyx

Gravity.—The figures have shown that at least 73 per cent of stones mature in the lowest minor calyx The primary calculus may thus originate in the lower pole and mature there—no doubt the commonest explanation—but on the other hand it may form elsewhere in the kidney and drop by gravity into one of the calyces of the lower pole where it matures.

Adhesion.—Adhesion of the primary calculus to a Randall's plaque would be one explanation of the fact that a calculus can remain in a top minor calyx where it matures, or a part of a stone may be impacted in a Carr's pouch.

Anatomical considerations.—A narrow and elongated neck of a calyx due to a congenital abnormality, pressure from tumours and cysts, or fibrosis from previous inflammation would impede the expulsion of a small calculus into the pelvis A dysfunction of the calycine musculature due to a neuromuscular defect would have the same result

Infection.—Infection may well interfere with the normal contraction of the calycine musculature, producing a type of ileus as in the intestine, and may favour stasis and retention of the calculi.

A classification of renal stone

Primary.—(1) Randall's stones formed on calcified plaques on the papillae—these probably also originate as a result of lymphatic obstruction; and (2) Carr's stones with one or more nuclei. These nuclei are calcium concretions which collect in forniceal pouches and may form one large stone or multiple small ones.

The origin of both these types of stones is in the renal tissue. They form on a segmental, or in the upper pole, possibly on a partial segmental basis If a metabolic



(a)



(b)

FIG 134—(a) P[illegible] (b) tracing to [illegible] lymphatic vessels [illegible] pole.

(By courtesy of the [illegible] Journal of [illegible])

disease is present, then usually all segments are involved and the [illegible] be bilateral.

Secondary stones originate initially in the pelvi-calyceal system [illegible] associated with infection, stasis, recumbency, vitamin deficiency, [illegible]

Treatment of primary renal stone

It is evident that the presence of a primary stone in the [illegible] of a disease and removal of the calculus alone may therefore [illegible] the patient and prevent recurrence. In a small percentage of [illegible] be one of metabolism or of the renal tubules themselves, and [illegible] surgical treatment may be necessary to deal with emergencies, [illegible] surgeon should be directed to a cure of the general disorder.

As a rule, however, the primary lesion is in the kidney itself [illegible]

Treatment of uretero-pelvic calculi

Whether uretero-pelvic stones have been passed spo[illegible] impacted, every effort should be made to discover from the [illegible] of origin in the kidney. When operating on stones imp[illegible] pelvis, even if the clinical radiographs have not indicate[illegible]

be possible to obtain further evidence at the time of the removal of the stones, by skiagrams of the kidney exposed at operation. These skiagrams frequently show changes not apparent in the clinical radiographs.

Although the various skiagrams according to present day standards sometimes fail to show pathological changes, the following facts may be observed. (1) *Residual* calculus in a calyx; (2) concretions in a "pouch" or a Randall's plaque. Rarely, the following changes are seen. (3) Hydrocalycosis affecting an isolated calyx or calyces; (4) *fine radial calcification* located to a pyramid.

Only when definite evidence of local pathological changes in the kidney is found, should a partial nephrectomy be performed.

Table III gives the number of uretero-pelvic stones and the site of origin in the author's series.

TABLE III

REMOVAL OF URETERO-PELVIC CALCULI (41) AND SIMULTANEOUS PARTIAL NEPHRECTOMY

Position of calculi	*Lower pole*	*Upper pole*
Pelvis (25)	21	4
Pelvis and ureter (3)	3	
Ureter (13)	12	1

It is thus probable that 87·8 per cent (36 out of 41) of these uretero-pelvic calculi matured in the calyces of the lower pole.

There are cases, however, of uretero-pelvic calculi in which skiagrams fail to reveal *any pathology and the stone is then merely removed by pyelolithotomy* or nephrolithotomy if it does not pass spontaneously.

Primary stones associated with secondary stones and their treatment

Secondary stones usually develop in the pelvi-calyceal system as a result of infection, stasis and obstruction. *Such an obstruction may be caused by a primary* calculus impacted in the pelvis or ureter. Moreover, a primary calculus which remains in the pelvi-calyceal system, even though it is not causing obstruction, may be responsible for persistence of infection. Its presence prevents sterilization of the urinary tract. *Secondary phosphatic stones may develop especially if the infecting organism* is a urea-splitter. *On the other hand the primary stone may* rapidly increase in size because of deposition of phosphatic layers, and thus it may have the outward [illegible] secondary [illegible]

[illegible]

may reveal the presence of a primary calculus and secondary characteristics [illegible] have been *superimposed* as a result of infection. Skiagrams of the exposed kidney may reveal changes in a segment of the kidney which indicate that it is pathological and stone-forming.

In these cases, a partial nephrectomy should be performed and the stone-forming segment excised. Any stones which remain should then be removed through the opening in the pelvi-calyceal system and all debris washed out. The kidney must not be closed until skiagrams have shown it to be free from calcareous material (Figs. 135 and 136).

If the kidney is markedly hydronephrotic from obstruction *due to stones*, then the removal of the lower pole of the kidney, if this is the pathological and stone-forming segment, will result in a reduction in the capacity of the kidney and an improved function. Hjort of Oslo (1953) has made a similar observation *and treats a* large hydronephrosis by partial resection of the elongated kidney and maintains that the dynamic efficiency is improved.



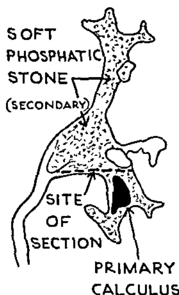


FIG 135—*Left* Pyelogram, *right* tracing to show solitary functioning kidney containing primary calculus in the lower pole and secondary phosphatic stones in the pelvi-calyceal system—infection Urea splitter—*B proteus*. Lower polar partial nephrectomy and removal of secondary stones through the partial nephrectomy incision Pedicle clamp compression four and a half minutes

(By courtesy of the Editor of Brit J Urol)





FIG 136—*Left* Pyelogram; *right*. tracing to show the state of the same kidney (Fig. 135) after operation Urine sterile Blood urea 22 milligrams per 100 millilitres.

(By courtesy of the Editor of Brit J Urol)

Recurrence of stone and its prevention

Recurrence of stone following operations may be (1) true—when an entirely new stone follows the complete removal of the original stone or stones; or (2) false—when a fragment or fragments of the original stone remains and further deposition of calcium occurs. For the purpose of comparison of results in the conservative renal operations, all recurrences, whether true or false, must be included.

It is difficult to obtain from the literature an accurate idea about the incidence of recurrence after partial nephrectomy. The number of cases recorded in any given series is often small and the length of time of the follow-up is seldom stated. It is clear from the figures previously shown that unless skiagrams are taken the recorded incidence of recurrence is of little value. Moreover, a recurrence may not be seen, say, 5 years after an operation and yet may be found after 10 years. The nature of the pathogenesis of stone makes it likely that recurrence of primary stone may be long delayed. In the author's series the recurrence rate was 7·9 per cent for infected and non-infected cases observed by radiographic examination over a period of up to 16 years. This percentage is capable of considerable reduction now that more knowledge on the subject has been obtained.

Causes.—(1) Failure to remove completely a stone-forming segment, or segments, of the kidney. The whole lower pole must be removed. In the upper pole a calycectomy is permissible if it is essential to conserve renal tissue.

(2) Fragments of calculi left behind in the pelvi-calyceal system. Skiagrams must be taken of the portion of kidney removed to prove that it contains all the stones for which the operation was performed. A skiagram must also be taken of the kidney tissue remaining as a check to ensure that no further stones or fragments are present.

(3) Blood clot allowed to remain in the pelvi-calyceal system may act as a nidus for the deposition of further stones and, moreover, may encourage infection. It invites pelvic obstruction, distension and extravasation of urine.

(4) Persistence or introduction of infection. Drainage of the renal pelvis after partial nephrectomy is rarely, if ever, necessary. It encourages the introduction of infection into the kidney which may jeopardize the result of the operation. No patient with stone can be considered cured until infection has been completely eradicated. This should be accomplished before the patient is discharged from hospital

(5) Faulty closure of the pelvi-calyceal system resulting in narrowing of a calyceal neck or the pelvi-ureteric junction with resulting stasis.

(6) Faulty position of the kidney after replacement. The kidney should be retained in a high position in the renal bed by nephropexy. Slight rotation of the kidney is thus obtained by this procedure so that drainage from the calyces is encouraged and kinking of the ureter obviated.

(7) Other factors. Obstruction and infection in other parts of the urinary tract should as a rule be eradicated before a partial nephrectomy is performed. General metabolic diseases such as hyperparathyroidism, cystinuria, vitamin A deficiency, and the like must also be corrected.

Partial nephrectomy in preference to pyelolithotomy and nephrolithotomy in the treatment of localized calculi

In the older conservative operations of pyelolithotomy and nephrolithotomy, no attempt is made as a rule, to correct any underlying factors which may, in part, be responsible for the formation of calculi—the stones are merely removed. After these procedures, the probability that further stones will form is considerable, as nothing has been done to try to prevent their formation. The usual recurrence rate of 15–45 per [illegible] of a [illegible] often [illegible]

the primary cause.

Renal tuberculosis

Hippocratic aphorism—be prepared to do the right thing at the right time, in which patient, attendants and external circumstances must co-operate

The results of surgical treatment in the past have been poor. The cases tended to develop urinary fistulae and wound infection, and haemorrhage and persistence of urinary infection usually made a subsequent nephrectomy necessary. Nephrectomy was thus considered the procedure of choice in unilateral renal tuberculosis without regard to the pathological anatomy.

In recent years, the trend of surgery has been towards conservative treatment by partial resection. The principal reasons for this change in outlook are as follows.

(1) The advent of anti-tuberculous drugs, for example, streptomycin, PAS (para-aminosalicylic acid) and isonicotinic acid hydrazide, and a knowledge of their use in pre-operative and post-operative treatment.

(2) Improved radiographic methods—aortography and renal angiography and improved intravenous urograms

(3) A better understanding of the basic principles involved in the selection of cases and the performance of the operation of partial nephrectomy.

(4) The realization that, contrary to the teaching of Albarran, tuberculous lesions of the kidney can heal spontaneously (Medlar and his colleagues, 1929)

The advantages of partial nephrectomy over nephrectomy

Advantages of partial nephrectomy are:—(1) conservation of renal tissue; (2) bilateral surgical treatment becomes possible; and (3) a local destructive lesion in a solitary kidney may be removed.

Semb (1949) was largely responsible for rekindling our interest in this subject. He considered that it was useful to draw a parallel between renal and pulmonary tuberculosis. As the surgical treatment of pulmonary tuberculosis had, in his opinion, given good results, he felt that the possibility of applying the same principles in the treatment of both pulmonary and renal tuberculosis should be examined. He divided his cases into three groups, in all of which medical treatment was essential.

Group 1.—Infiltration without macroscopic destruction, the so-called "parenchymatous" form—medical treatment only

Group 2 —Local destruction with cavity formation—excision of this portion of the kidney by partial nephrectomy. The patient's own powers of healing together with modern medical treatment are relied upon to destroy any other areas of infiltration in the renal parenchyma, or the secondary spread to the renal pelvis, ureter and bladder Semb considers that there is less chance of the spontaneous healing of a macroscopic cavity in the kidney than in the lung and, in practice, one can assume that healing will not occur

Group 3 —Total destruction—nephrectomy.

Choice of case for partial nephrectomy

General principles —It must be realized that patients suffering from genito-urinary tuberculosis have suffered or still suffer from general tuberculosis All cases should therefore be given a course of medical treatment including the use of anti-tuberculous drugs prior to operation. If active lesions are present in extra-urogenital organs then these lesions should be treated in the first instance, as the operation on the kidney might re-activate the disease.

An exception may be made to this rule, however, when it is considered that an acute lesion of part of the urogenital system is causing such a toxaemia that improvement in the patient's general health is not possible without its eradication. A secondarily infected tuberculous pyonephrosis or tuberculous epididymo-orchitis would come into this category.

The location of destructive lesions in the kidney

Destructive lesions are most common in the upper pole, whereas in stone formation, the lower pole is most frequently involved The statistics in Table IV are of interest.

TABLE IV*

Position	*Destructive tuberculous lesions* (Carl Semb)	*Renal calculi—stone forming segments* (Hamilton Stewart)
	Per cent	Per cent
Upper pole only	66 (42)	21 (29)
Central division only	20 (13)	0 (0)
Lower pole only	14 (9)	79 (111)

* Kidneys in which more than one division or segment were diseased are not included in Table IV, hence the rise in percentage compared to Table III

An explanation of these facts probably lies in the suggested aetiology of the two conditions. The author would not like to offer a definite explanation of the peculiar difference in the localization of these two forms of renal disease. Certain differences in their causation may be pointed out. Tuberculous foci are considered to be blood borne The upper pole is supplied by three groups of arteries (Graves, 1954)—apical and upper segmental arteries and branches from the posterior segmental artery—whereas the lower pole is supplied entirely by the one vessel—the lower segmental artery. As the upper pole is supplied by a larger number of arteries than the lower or intermediate portion of the kidney, then it could be expected that destructive tuberculous lesions would be more common in the upper pole.

Stone formation would not appear to have any relationship to arterial renal supply but is probably dependent as previously described, on inadequate lymphatic drainage. Gravity may have some influence on the ultimate position of stones, but not on the localization of tuberculosis.

Investigation of a case to determine suitability for partial nephrectomy

An accurate history is taken and a search made for evidence of any dormant or active extra-urogenital lesions.

A full urological investigation is carried out, which will not be referred to in detail The intravenous pyelograms should be of first-rate quality Repetition of the examination may be necessary before the desired standard of pictures is obtained. Ureteric compression is essential. Ureteric specimens should be obtained from each kidney for urea estimation, cytological examination and microscopical and cultural examination for tubercle bacilli. Ascending pyelograms should be obtained only if the intravenous pyelograms fail to furnish the required information There is always the danger of dissemination of the disease by pyelovenous or pyelolymphatic backflow, and the possibility of introducing infection. The cystoscopic examination will enable the surgeon to portray in diagrams the site of tuberculous lesions, so important in future follow-up of the case.

If the pyelograms show that at least one-third of a kidney is functioning satisfactorily and the calyces are normal, then aortography and renal angiography should be delayed until the patient has received medical treatment for 4–6 weeks Extensive destructive lesions involving all divisons of the kidney rule out the case for conservative surgery. There are cases, however, in which doubt exists and aortography and renal angiograms may be advisable at this early date

The pyelograms demonstrate the presence of cavities communicating with the pelvi-calyceal system and renal angiography is relied upon to show closed destructive lesions, a relative absence of vessels being noted in the affected areas.

The main problem is to ensure that destructive cortical lesions are not missed.

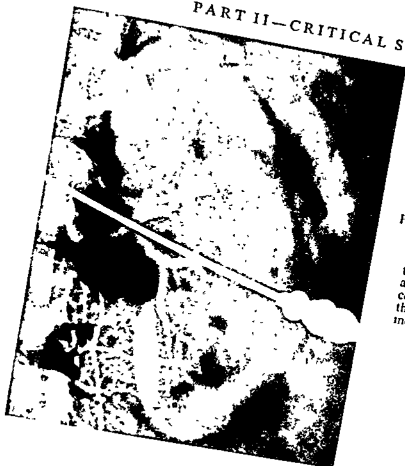


FIG. 138—Angiogram of solitary left kidney. Demonstrating destructive lesion in centre of kidney. N B—The vessels to the central portion stop abruptly before reaching the cortex The central portion is thus avascular. These findings indicated a destructive lesion



FIG. 139—Photograph of the median portion of the solitary kidney showing tuberculous abscess

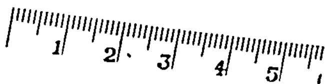




FIG 140 —Intravenous pyelogram eighteen months after operation (Compression used) Urine free from pus cells and tubercle bacilli



FIG 141.—Intravenous pyelogram eighteen months after operation (no compression).

Examination of the kidney at operation may reveal no evidence of their existence. If there is still doubt, a renal angiogram should be obtained on the exposed kidney, the angiographic medium being injected into the aorta just proximal to the renal artery in preference to injection into the renal artery itself. The long needle used in the former procedure does not interfere with the positioning of x-ray films or the cone of the x-ray apparatus.

The management of a case considered suitable for partial nephrectomy

In the majority of cases which are presented to the urologist for treatment, any extra-urogenital lesions are quiescent or have been cured. I shall therefore consider the treatment of these cases only.

Pre-operative medical treatment.—A period of about 6 weeks should be spent, preferably in a sanatorium. During this time, the case will receive treatment with anti-tuberculous drugs. The important principle in treatment is to combat acute lesions and to improve the patient's general health, and yet to avoid making the organism drug resistant. It is essential that the anti-tuberculous drugs shall give cover during the operation and in the post-operative period, and will thus prevent infection not only in the wound in the kidney, but also in the parietal incision. Although the basic principles in the medical treatment are the same in the various sanatoria, the regime varies slightly.

Research has shown that in the use of the anti-tuberculous drugs, if two are given together the risk that the tubercle bacillus will become insensitive is reduced. Two (or three) of these drugs are thus always given together for varying periods of time and then the combination is changed.

The case is reviewed again at the end of this period of medical treatment. The urine is examined for tubercle bacilli, intravenous pyelograms are obtained, and also renal angiograms. Rarely, ascending pyelograms will be required, but if so, the operation should not be performed until 14 days have elapsed after the examination in order to allow any reaction to subside. As I have already mentioned, certain cases originally considered suitable for conservative surgery may now prove unsuitable, and nephrectomy may be the only possible course.

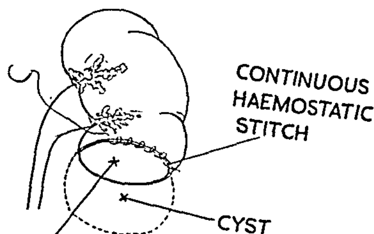


FIG. 142.—Method of treating solitary cyst of kidney.

The night before the operation, the patient is given all three of the anti-tuberculous drugs in full dosage. Streptomycin 1 gramme is given immediately prior to the operation, and thereafter the three anti-tuberculous drugs are administered for a period of 14 days. Subsequently, the standard medical treatment is given for a period of 1 year.

If the post-operative functioning tissue is only a part of one kidney, care must be taken to avoid the intake of excessive fluids with the associated danger of oedema.

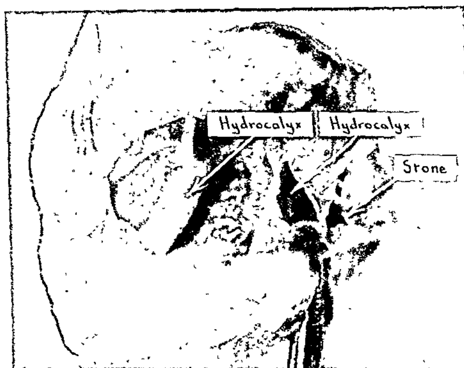


FIG 143—Specimen removed by partial nephrectomy—massive hydrocalycosis due to obstruction by a calculus impacted in a major calyx Two cavities representing the minor calyces

Solitary cyst and localized hydrocalyx

A solitary cyst can occasionally be dissected out with ease and with little bleeding. It is usually advisable, however, to excise the major portion of the cyst wall and control haemorrhage by a running stitch The cavity lined by the remaining portion of the cyst wall, is then obliterated by

A hydrocalyx must be distinguishe

underlying pathology, for example, growth, stone, and the like, must be sought for If conservative surgery is decided upon, a partial nephrectomy should be performed through healthy parenchyma Failure to do this may result in a recurrence of the condition, or a fistula (Fig. 143)

Hydatid cysts may occur in the kidney.

Removal of infarcted and severely lacerated portion of kidney

In the operation for hydronephrosis due to ureteric or uretero-pelvic obstruction by a lower polar artery, certain urologists advise that after division of the obstructing vessel the infarcted area of the kidney should be removed to prevent subsequent complications. This was the method of treatment adopted by the author in preference

to uretero-pelvic anastomosis in front of the obstructing vessel until he devised his nephroplasty operation (Hamilton Stewart, 1947). This latter operation enables the obstruction to be removed without interfering with the renal blood supply or the uretero-pelvic continuity. The question of infarction need no longer enter into the treatment of hydronephrosis due to a lower polar artery.

In those cases in which surgical intervention is decided upon for the treatment of lacerations of the kidney as a result of injury, it is probable that in the past many kidneys have been unnecessarily removed. It is possible to conserve portions of kidney which will function normally, and it must be remembered that one-third to one-half of a kidney can sustain life. Renal tissue should be removed only when it has been severed from its blood supply or the pelvi-calyceal system.

Tumours

Partial nephrectomy will not often be the method of choice in the treatment of tumours of the kidney. If the surgeon can be sure, and this must rarely be so, that he is dealing with a benign tumour, then the method is ideally suitable. Possibly it has a place in the treatment of certain malignant tumours arising in a solitary kidney, but radiotherapy may be considered an alternative method of treatment.

GENERAL PRINCIPLES IN THE OPERATION OF PARTIAL NEPHRECTOMY

How much renal tissue is necessary to sustain life?

A man can live in good health and have a normal blood urea provided he possesses one-third to one-half of one kidney The remaining kidney tissue must, however, be normal.

An intravenous pyelogram obtained 18 months after removal of the lower half to two-thirds of the organ for tuberculous disease is shown (Fig. 144). The other kidney had been previously removed for the same disease. The urea concentration test is as follows:

Blood urea: 42 milligrams per 100 millilitres

Urea concentration test (15 grammes of urea in 100 millilitres of water. No fluid for 8 hours):

After urea hours	millilitres	*Urea* per cent	grammes
1	90	1·81	1·63
2	100	1·94	1·94
3	60	2·25	1·35

Urine: pus—nil No tubercle bacilli.

Control of infection

When the operation has to be performed in an infected case, it must be done under cover of antibiotic (and sulphonamide) treatment if possible. The surgeon may feel it wise to use more than one antibiotic. As the chances of sterilization of the urine in the presence of stones is unlikely, and as there is a real danger that the organism may rapidly become insensitive, the ideal time for the sterilization of the urine is immediately after the stones have been removed. A maximum blood concentration of the antibiotic (and sulphonamide) should therefore be present at this time. In the case of streptomycin the initial dose should be a large one (1 gramme) given 4 hours before the operation. At the termination of the operation a further 1 gramme should be given, and thereafter 0 5 gramme 6-hourly until 8–9 grammes in all have been received by the patient. Garrod (1951) has stated that in the case of *Bacterium aerogenes*, resistance may develop within 24 hours, and if treatment should fail there may be no second chance as resistance to streptomycin is permanent.

On occasions in the author's cases, a positive culture of an organism has been obtained from the surface of a calculus or from a calyx when no growth was obtained from the patient's urine before operation. If this should prove to be the case, then the appropriate antibiotic must be given immediately this fact is known and a full course administered

The prevention of a tuberculous infection in the renal wound and in the incision in the abdominal wall has been considered under the special heading. In the relatively small number of operations for renal tuberculosis carried out by the author, there has been no single case in which a tuberculous infection of kidney or parietes has occurred, nor any fistula.

Operation for bilateral disease

As a general rule, when it has been decided that a partial nephrectomy should be performed on both kidneys, the better kidney should be operated upon in the first instance so that this kidney may be functioning satisfactorily at the time of the second operation. It may prove inadvisable to retain the second kidney which may prove to be more diseased than was realized As the surgeon is aware of the condition of the first kidney, he will be able to decide whether a nephrectomy is feasible.

Incision, exposure and mobilization of the kidney

The majority of surgeons use an incision through the bed of the twelfth rib The incision can, if necessary, be enlarged anteriorly without injury to nerves It is wise, as Lane (1950) suggested, to depress the kidney bridge during the period of excision of the rib, thus reducing the danger of injury to the pleura. Any of the recognized incisions may be used however Great care is taken in the delivery of the kidney into



FIG. 144 —Intravenous pyelogram (20 minutes) after removal of one-half to two-thirds of a solitary kidney for tuberculous disease

the wound and squeezing or compression avoided so that the position of the stones in the kidney is not disturbed or tuberculous material expressed into the venous system. The under-surface of the pelvis and pelvi-ureteric junction are displayed with the minimum amount of dissection and interference with the surrounding connective tissue with its contained lymphatics.



FIG. 145.—Straight x-ray (*left*) and pyelogram (*right*) of exposed kidney taken at operation. The operation was performed for the cluster of stones in the middle calyx. The presence of the small calcific body in relation to a minor calyx of the lower pole was discovered on x-ray of the exposed kidney. The middle third of the kidney (with its contained stones) and also the lower pole were removed.

(*By courtesy of the Editor of the British Journal of Urology.*)

X-ray examination of the exposed kidney

In all operations for stone in the kidney, the final assessments of the case can only be made after study of high quality radiographs obtained of the exposed kidney (Fig. 145). Small calcific bodies may be present though not visible on the pre-operative clinical radiographs. At least two radiographs should be obtained in order to rule out the possibility of artefacta. After the kidney has been mobilized a sling of sterile gauze is slit as in Fig. 146 and is passed around the kidney. The slit allows the sling to encircle the pedicle and the kidney is gently lifted as far out of the wound as possible. If preferred a strand of nylon may be placed under each pole and grasped together above the kidney with a pair of artery forceps. The kidney is thus supported rather like a hammock. This latter procedure reduces the risk of marks on the skiagrams, but is less secure. The outer edge of the wound is firmly depressed by the sterile cone attached to the x-ray tube (Fig. 147). The following is abridged from Dr. Carr's description of technique:

"It is essential to use a special cone with a rectangular end and this end is closed by a sterile linen diaphragm stretched tightly across the opening. The kidney is then gently but firmly pressed against the diaphragm so that it is completely immobilized

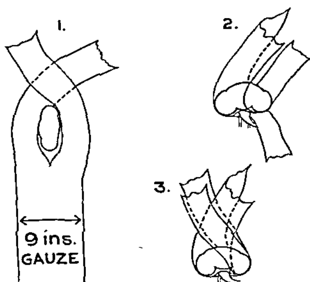


FIG 146.—A method of applying gauze sling.
(By courtesy of the Editor of the British Journal of Urology)

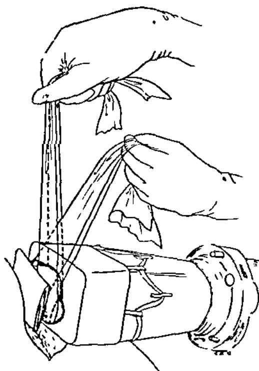


FIG 147.—A method of x-raying the kidney.
(By courtesy of the Editor of the British Journal of Urology)

whilst the picture is being taken. The film is inserted into the wound behind the kidney and in contact with it. The most suitable film is non-screen Ilford Standard Speed which is specially packed for the purpose, 12×9 centimetres, in paper envelopes. These are sterilized in the ordinary formalin sterilizer and when they are to be used they are put in special bags of thin rubber which are also sterilized and used once only. The x-ray machine has a high output rotating anode tube with a fine focus so that the exposures are kept to the minimum. The films are developed in special developer for 30 seconds and are available for inspection in a minute and a half." Further details of the technique are available in the published account (Carr, 1955).

Pyelograms of the exposed kidney may be necessary to determine the exact relationship of calcified bodies to the pelvi-calyceal system. A small Crile's clamp is placed on the ureter and 10 millilitres of Pyelectan, diluted 1 : 4, are injected through the finest hypodermic needle passed obliquely into the renal pelvis. Skiagrams may reveal inadequate filling and if so a further injection is made. Skiagrams must be taken in pairs for the reason already mentioned.

When operating upon a tuberculous kidney a straight skiagram should be taken in all cases as it may reveal a caseous lesion. If the angiograms taken prior to the operation are not of the desired quality, then they may be repeated on the kidney when exposed. The author prefers the injection to be made into the aorta directly proximal to the renal artery. The needle is passed in the usual way below the left twelfth rib and the point of the needle can be directed by a hand inside the wound so that it is in direct contact with the aorta. The kidney is then delivered as described, the casette placed in position and the injections made at the desired time. In this way the needle does not pass through the wound and does not interfere with the placing of the casette or the x-ray tube. When the left kidney is operated upon the patient can be placed in the usual kidney position, but when an angiogram of the right kidney is required, the patient is placed in the prone position. This variation is necessary in view of the position of the aorta.

Haemostasis

Ligation of the vessels in the hilum

The kidney is a segmental structure and it is thus possible to remove one or more segments without damage to the remaining part. It must be remembered, however, that the arteries are end arteries and proximal ligature of any vessel at the hilum may result in infarction of renal tissue of greater or lesser extent than the segment or segments to be removed. In order to avoid this danger, surgeons advise a thorough exposure of the renal pedicle in order to observe the artery and vein which appear to supply the portion of kidney to be removed. Temporary occlusion of these vessels may result in discolorat [illegible] the area of blood supply. After injection c [illegible] artery, the author found that t [illegible] did not correspond exactly to the desired plane of section. [illegible] that it is necessary to ligate or control by "figure-of-eight" stitches, the vessels in the renal wound and not by proximal ligature at the hilum. Even an accessory or lower polar artery should not be ligated proximally unless it is actually "attached" to the portion of renal tissue which is to be removed. The parenchymal or pedicle clamp is released [illegible] the main vessels.

[illegible] up to the renal pedicle, makes his incision [illegible] near the hilar border, and opens out the wound with forceps. Those vessels passing to the portion to be removed are then ligated. In this way, the risk of dividing vessels passing to the kidney tissue to be retained is reduced. The procedure, however, necessitates the use of a pedicle clamp for a long period with resulting danger of prolonged renal ischaemia. This is par-

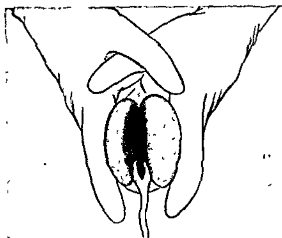


FIG 148—The index fingers of the assistant used as a haemostatic clamp

ticularly undesirable when the operation is performed on a solitary kidney, which is often the case

Control of haemorrhage during section of the kidney

Control of haemorrhage is important not only for the general well-being of the patient, but in order to facilitate an accurate examination of the pelvi-calyceal system after section of the kidney. The safest method is by the use of parenchymal compression near the site of section Ischaemia of only a small portion of the kidney thus results. The index fingers of the assistant's hands clasped as illustrated in Fig 148 is efficient. This method is apt to be tiring to the assistant, who at times must have staying power. The author's rubber covered parenchymal clamp which has adjustable blades (Fig. 149) is also satisfactory When this method of control does not permit the surgeon to obtain the necessary knowledge of the pelvi-calyceal anatomy then temporary compression of the renal pedicle is used, either by digital compression by an assistant, a tourniquet of rubber tubing, rubber bands or tape, or by a rubber-shod pedicle clamp as devised by Cráfoord Van Slyke and his colleagues (1944) have stated from experimental evidence on dogs that it is possible to clamp the renal pedicle for as long as 3 hours without causing permanent damage to renal function The blood urea nitrogen concentration rose, however, in the first 2 or 3 days to over

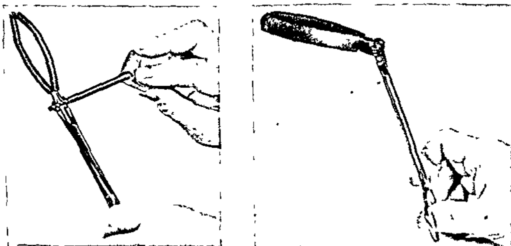


Fig 149—Parenchymatous clamp. The angle of the blades can be altered and fixed by the ratchet fitting
(*Made by Messrs Thackrays of Leeds*)

150 milligrams per 100 millilitres but by the fourth day, before retention became fatal, the clearance of urea began to improve and the concentration of blood urea to fall. It ultimately returned to normal values over the course of the next 2 to 3 weeks. Compression of the renal pedicle thus causes depression of the renal function, the degree depending on the length of time the clamp is used at any one period. If the operation is performed on a solitary kidney and when it is realized that a portion of this kidney is to be removed, even a temporary interference in the function may be a serious matter.* Prolonged compression would result in permanent damage to the kidney and the risk of thrombosis. The author dislikes its use for more than 5 minutes. It is then released and haemorrhage controlled for one to 2 minutes by digital compression of the kidney. Compression may then be re-applied. Several such changes in the control of haemorrhage may be necessary but the aim should be to use the

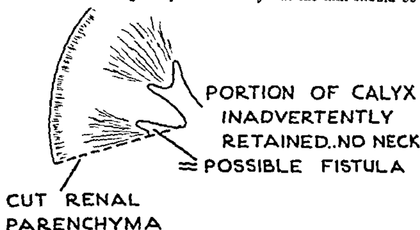


FIG 150.—Danger of retaining a damaged calyx.
(By courtesy of the Editor of the British Journal of Urology.)

pedicle clamp for as short a period as possible. During compression of the renal wound, blood may collect in the pelvi-caecal system and it is essential to ensure that all clot is removed at the end of the operation.

Certain details in the surgery of the kidney

When operating upon the kidney, the surgeon must constantly have in mind the fact that the arteries to the kidney are end arteries and injury of a main vessel will result in a large infarct. Serious complications may follow, particularly if the urine is infected.

So far as the pelvi-calyceal system is concerned, it is essential that after operations on the kidney, each calyx shall possess a neck of sufficient calibre to drain away the urine. If not, hydrocalycosis, persistent infection, and the like, may occur. It is even more essential that a calyx or portion of a calyx with its papilla should not be left without a channel for drainage (Fig. 150). Such an oversight is likely to cause a permanent fistula. If a calyx and its neck are damaged and cannot be accurately reconstructed, it is preferable to excise them completely.

Partial nephrectomy incisions

The incisions that can be used are. (1) straight section; (2) wedge section; (3) decapsulation of portion of kidney to be removed, followed by section of kidney; (4) prolongation of the incision into the pelvis; or (5) prolongation of the incision into the cortex (nephrolithotomy)

The section can be made with a scalpel or diathermy. The latter method may cause deep necrosis and is not advised. The author uses the wedge resection in the plane previously depicted (Fig. 125*a*, p. 190) and the capsule is cut at the line of the incision

* Refrigeration of the kidney may be helpful, but sufficient experience has not yet been obtained.

The flaps should be ¼ inch in length. This incision facilitates closure of the renal wound and the flaps when brought together tend to control oozing from the cut surfaces. These flaps must not be subjected to trauma.

Calculi are often present in the pelvis of the kidney or upper ureter in addition to those in the kidney. These pelvic or ureteric stones can be removed at the start of the operation by pyelolithotomy or ureterotomy. If the lower pole, however, is the stone-forming segment, as is usually the case, it is often possible, with forceps, to extract the stone through the divided major calyx. If necessary, however, an incision in this calyx can with ease be prolonged into the pelvis (Fig. 125*a*). A staghorn calculus arising in the lower pole may be extracted in the same way. Occasionally the partial nephrectomy incision has to be enlarged and a nephrolithotomy performed. In the extraction of stones from the pelvis and other calyces, great care must be taken to avoid trauma. This is one of the commonest causes of primary intra-pelvi-calyceal haemorrhage.

Line of section of the kidney

Two viewing boxes at eye level and on the same support should be placed near the surgeon. On the one is placed a clinical pyelogram and on the other a protected [illegible]

The aim of the surgeon should be to retain functioning renal tissue which is free from stone and calcific bodies which have a direct relationship to the fornices of the calyces. The author has already described that these bodies are often to be seen in the stone-forming pathological segments and they are removed in the resected renal tissue along with the stone.

Rarely, however, stones may be present in one segment of the kidney and yet calcific deposits may be observed in another segment also (Fig. 145, p. 214). If pyelograms show that these deposits are in direct relationship with the fornix of a calyx and are in fact concretions as defined by Carr, then this segment must also be removed in addition to the segment containing the stone.

If, however, skiagrams of the exposed kidney show calcified bodies throughout the kidney in addition to the stone for which the operation is being performed, then it is clear that partial nephrectomy cannot be a curative operation. In these cases the stone should be removed and the kidney tissue left undisturbed, or the segment in which the stone lies should be resected. It should be realized that these procedures should not prove curative but the patient may probably remain free from trouble for many years. It is possible that such a case is one of a disordered calcium metabolism.

The excision should preferably be by wedge resection as described and the apex should lie along a line which can be determined as follows:

Resection of the lower pole

(*a*) The line extends across the kidney from the top of the convex lower border of the pelvis. This line usually passes at right angles to the long axis of the central portion of the kidney but may vary slightly according to the calyceal anatomy. The aim should be to cut through the lowest major calyx as it joins with the pelvis (Fig. 151)

(*b*) The pyelogram taken of the exposed kidney is examined and the line of section determined. The distance of this line from the lower edge of the kidney is measured by a large caliper which is not allowed to touch the film. As little, if any, magnification has occurred in this x-ray the exact line of section can be marked on the exposed kidney.

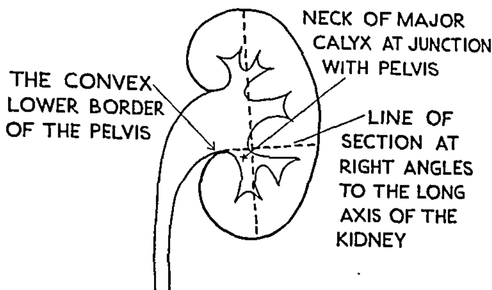


Fig 151 —Line of section

(*c*) If the calyceal anatomy is abnormal, then after compression of the renal pedicle, the lower pole may be split in the long axis until the pelvis and lowest major calyx are opened Having determined the correct depth, the renal flaps can then be fashioned.

Resection of the upper pole

Resection of the upper pole is fraught with more danger. The artery to the posterior segment lies close to the superior pelvi-calycine junction. This fact has also been noted by Graves (1954). It is therefore unwise to attempt to remove the whole of the superior major calyx when operating for stone as there is a danger of injuring the vessel with a resulting infarct of the posterior part of the kidney. Moreover, it is not essential (as in the lower pole) that the whole of the major calyx be removed.

It is also wise when performing a partial nephrectomy for stone to retain a thin lip of the medial or hilar border of the upper pole. In this way, the renal vein which lies in direct relationship to this part of the kidney is protected.

Resection of median portion

In tuberculosis, the disease most commonly affects the upper pole. The middle part, however, may be involved and the poles remain free. In the latter case the lines of section have to be accurately determined by study of the pyelograms and renal angiograms. The calyces which have to be removed are known and the appropriate lines of section marked on the kidney. Following the operation, the kidney tissue which remains is drained by an upper and lower major calyx, and the kidney would thus appear to have a bifid pelvis. A wedge resection is used on each side of the tissue to be removed to facilitate closure of the renal wounds. No attempt is made to approximate the two halves of the kidney, the space being filled with perirenal fat.

Closure of the wound in the kidney

Surgeons differ in their views as to the best method of closing the renal wound. Most are agreed, however, that accurate closure of the pelvi-calyceal system is essential. A running stitch of 0000 plain catgut in a fine needle is used. Although the main vessels have been controlled by ligation or figure-of-eight stitches, some oozing occurs from the cut surface. In order to control this, fat, muscle, fibrin foam, Oxycel, and the like, have been sutured between the flaps and if the capsule has been dissected

free, this is closed firmly over these foreign bodies Lowsley (1933) uses catgut tape for the approximation of the capsular incision.

The author is of the opinion that foreign bodies encourage infection and that their use is unnecessary. He considers that many of the complications which have followed partial nephrectomy are due to the sloughing of renal tissue primarily as a result of interference with blood supply from faulty suturing A certain amount of ischaemia and necrosis occurs after every incision in the renal parenchyma. When small peripheral arteries which are end arteries, are severed, the area of ischaemic necrosis is small (1-2 millimetres) but if larger vessels are included in sutures, then the necrosis

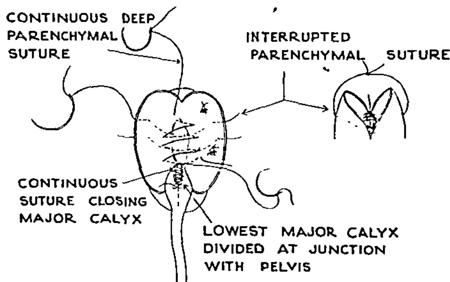


FIG 152 —Closure of renal wound
(By courtesy of the Editor of the British Journal of Urology)

will be considerably greater. All sutures, therefore, which cut off or strangle the blood supply are bad. They not only may cause necrosis of portions of renal tissue with risk of infection and secondary haemorrhage, but they may also cause, for the same reason, fistulae Cobbler stitches, mattress sutures, and the like, are thus to be condemned.

The author performs a cuneiform or wedge partial nephrectomy as shown in Fig 125*a* When suturing the renal flaps together, for after all that is what they are, the sutures of 000 plain catgut are not placed nearer together than ¼ inch and the same distance from the edge of the wound, and they are lightly tied From practical experience, this form of suturing does not interfere with the blood supply of the flaps (Fig 152) Then again it is important that any blood which may ooze from the renal flaps shall escape from the renal wound and pass out to the exterior through the renal space drain It should not be permitted to pocket in the renal wound or escape into the pelvis of the kidney In order to avoid these complications the renal capsule is not sutured separately, but is merely brought together by the interrupted parenchymal sutures described Adequate drainage to the exterior between the sutures is thus possible

Correct position of the kidney after replacement

Gravity would appear to play some part in the maturation of stones in a dependent calyx. Thus after a partial nephrectomy operation, the kidney should be placed at the top of the renal space and retained there by suturing the renal fascia below it.

The fascia thus acts as a sling A few of these sutures can with advantage be placed through the quadratus lumborum muscle.

This procedure also straightens out the ureter and avoids kinking of the ureter with subsequent obstruction

Drainage of renal space and vesical drainage

A drain is placed down to the kidney and retained for 5 days, an underwater seal being used if desired An indwelling urethral catheter is used during the immediate post-operative 12 to 24 hour period so that any haemorrhage into the bladder may be recognized, should it occur, and clot retention prevented by irrigation.

COMPLICATIONS AFTER PARTIAL NEPHRECTOMY

Mortality

This is about the same as after pyelolithotomy—2·58 per cent (Abehouse and Lerman, 1950). The author had 2 deaths out of 152 operations (1·3 per cent). One patient died from pulmonary embolism and the other from an unrecognized clot retention of the bladder.

Primary haemorrhage

Intrarenal

This usually occurs as a result of trauma to the pelvic lining and particularly to the neck of the calyces by extraction of stones

Extrarenal

Inadequate haemostasis at the operation is responsible. Although this haemorrhage usually escapes to the exterior through the drainage tube, a haematoma may develop under the flaps and rupture through into the pelvi-calyceal system.

Secondary haemorrhage and urinary fistulae and their causes

These complications are considered together as the author is of the opinion that the same basic causes are usually responsible for both conditions. In the author's cases, secondary haemorrhage occurred only in rare instances, was never sufficiently severe to cause anxiety, and a nephrectomy for this reason was never necessary Temporary urinary fistulae occurred on two occasions and persisted in one case for 7 days, and in the other for a few days only. It is probable that in one of the cases this complication was due to the division of a lower polar artery and that the infarcted area was more extensive than the tissue removed in the lower polar partial nephrectomy.

Causes.—(1) Interference with the blood supply. This subject has already been discussed.

(2) Extravasation of urine into the renal wound. This complication may result in necrosis of tissue as in extravasation elsewhere, secondary haemorrhage, infection and fistula formation may follow. (*a*) inadequate closure of the calyceal neck (and pelvis); (*b*) persisting pelvi-ureteric obstruction, this may be due to a calculus which has been dislodged unknowingly from a calyx or to blood clot, or to an unrecognized co-existing ureteric lesion; and (*c*) faulty position of the kidney after replacement with resulting kinking of the ureter and obstruction.

(3) Infection has already be considered, but the author would like to stress the inherent danger of the insertion of drainage tubes into the kidney. Drainage of the kidney following partial nephrectomy is inadvisable and very rarely necessary. The drainage tube may cause necrosis of renal tissue with subsequent danger of secondary haemorrhage and fistula formation, and its use encourages the introduction of

infection into the kidney. Immediately such a tube has been removed, any infection must be treated energetically. The introduction of a urea-splitting organism down or around the tube may seriously jeopardize the result of the operation

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PARALYSIS OF THE LARYNX

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Paralysis of the larynx may be unilateral or bilateral, complete or incomplete, and either of central or peripheral origin.

CENTRAL PARALYSIS

Lesions of the central nervous system giving rise to recurrent nerve paralysis are found in a variety of conditions, the most commonly encountered being tabes dorsalis, glosso-labio-laryngeal paralysis and vascular disorders affecting the bulbar region Although in such cases the symptoms of laryngeal obstruction tend to be progressive, they develop relatively slowly and the causative disease is often quite advanced before the laryngologist has to be consulted. Paralyses of the pharynx giving rise to difficulty in swallowing are frequently associated, and these may give rise to cough and choking by causing overspill of saliva and fluids into the larynx.

Unless the bulbar palsy is due to syphilis treatment is mainly palliative, but since the laryngeal obstruction is often incomplete, operative treatment to restore the airway is seldom required When, however, there is dyspnoea giving rise to increasing distress, tracheostomy will relieve and should not be withheld in spite of the eventually unfavourable outlook.

PERIPHERAL PARALYSIS

The recurrent laryngeal nerve is the motor nerve to the intrinsic muscles of the larynx Owing to the length of its course and anatomical relations in the neck, as well as in the thorax, it is particularly vulnerable to injury and disease.

According to Semon's law, in all lesions of either the centre or trunk of this nerve, those fibres supplying the abductor muscle, the crico-arytenoid posticus, are first involved, whereas the adductors may continue to act for a variable period of time. Except in gross lesions, therefore, when complete paralysis will occur at once, the abductor may be the only muscle affected and recurrent nerve palsy is frequently described as abductor paralysis of the larynx. Although the validity of this law has been challenged by many authorities, it is indisputable that in practice almost all cases of laryngeal paralysis present themselves with fixation of the vocal cords in or adjacent to the midline When the lesion is long-standing this fixation is perpetuated by disuse atrophy of the affected cord and ankylosis of the crico-arytenoid joint. Mechanical fixation of one or both cords due to ankylosis has also been described [illegible] or repeated laryngeal infections.
[illegible] irradiation treatment for malignant disease is also [illegible] ation of the cords in or near the midline. Ankyloses of the crico-arytenoid joint closely mimic recurrent nerve paralysis, and when the fixation is bilateral it may become necessary to restore the airway by surgical means.

BILATERAL ABDUCTOR PARALYSIS

Bilateral abductor paralysis of peripheral origin is almost always due to injury to the recurrent laryngeal nerves during thyroidectomy. The nerves are most often

damaged during detachment of the thyroid lobes from the side of the cricoid cartilage, or they may be accidentally included in ligation of the inferior thyroid arteries. According to Thornell (1952) the incidence of bilateral abductor paralysis following thyroidectomy varies between 0·3–7 per cent, the difference being explained by the varying skill of the surgeons concerned and the proportion of difficult cases they are called upon to treat. One safeguard against this accident, which is not always observed, is routine pre-operative mirror examination of the larynx before all thyroid operations in order that the presence of an unsuspected unilateral palsy may be noted. Particular care can then be taken to avoid injury to the nerve on the other side.

Symptoms

Dyspnoea

The cardinal symptom of bilateral abductor paralysis is dyspnoea and its severity is influenced by several variable factors such as the rapidity of the onset of the paralysis, the age of the patient and the width of the glottic chink.

When the paralysis has developed gradually, as in many central cases, tolerance to laryngeal stenosis is more readily acquired and life is sustained with a reduced airway which would give rise to urgent dyspnoea if of sudden onset. Furthermore, owing to the nature of their illness many of these patients are elderly and bedridden, so that calls on their physical activity are slight. According to Lawson (1955) some vigorous young people also compensate quite well, and it is not until they reach late middle life that increasing muscular weakness, rigidity of the chest walls and chronic bronchitis lead to bouts of increasingly severe dyspnoea, particularly on exertion or when they are suffering from respiratory infections

The width of the glottis is influenced by the completeness of the abductor paralysis. If it is complete the cords lie in the midline and respiration is only possible through the small gap in the posterior commissure of the larynx caused by the forward displacement of the arytenoids, which are no longer braced back by the posticus muscle On the other hand, if the paralysis is incomplete slight powers of abduction may remain and the cords are then seen to be in the paramedian position on respiration. In such a case the airway is sufficient for moderate activities and this possibly accounts for the long delay that often occurs between the thyroid operations and the complaint of any serious difficulty in breathing. In all cases of bilateral paralysis breathing in is more impeded than breathing out, owing to the valvular shape of the vocal folds which tend to be sucked together on inspiration and blown apart on expiration

Stridor

Stridor is often a marked feature, causing loss of sleep as well as social embarrassment It is sometimes attributed to other causes, and the writer has seen a young woman who had been treated for asthma for seven years following thyroidectomy before the true nature of her disability was suspected.

Vocal changes

Speech is characterized by short cut-off phrases, interspersed with noisy inspirations which are too shallow to permit of normal sentences before the next crowing inspiration is due. The voice itself may be clear if the cords are in close apposition

General activity

Owing to lack of oxygen, general activity is much reduced and a severe strain on the cardiovascular system may ensue

SURGICAL TREATMENT

Spontaneous recovery of an abductor paralysis following thyroidectomy has frequently been observed Mostly this occurs within a few months of the onset, but instances of

recovery as late as twenty months after the injury have been reported. Recovery of even one paralysed vocal cord will relieve the patient much more effectively than any operation so far devised; it is therefore extremely important that no premature procedure of a type likely to prejudice this possibility should be embarked upon. In practice this means that intervention must be limited to tracheostomy for the relief of threatened asphyxia until such time as all reasonable prospects of spontaneous recovery have been given up.

Tracheostomy

In performing tracheostomy it is desirable to intubate between the third and fourth rings of the trachea, well below the level of the cricoid cartilage. This allows the shield of the cannula to fit snugly in the lower part of the neck between the sterno-mastoid muscles, where it can be conveniently hidden by a collar or a scarf. A well-planned tracheostomy removes all risk to life or health, and restores the patient to full activity during the period of waiting for possible nerve recovery. A flap valve for speech purposes can be incorporated into the outer end of the tracheostomy tube; this valve opens on inspiration and closes on expiration, permitting of fluent speech. The resulting voice is often very satisfactory. A recommended pattern of tracheostomy tube is that designed by Negus, in which the outer end of the tube is slightly funnelled to allow the flap valve to be countersunk without encroaching on the lumen. In this way it fits flush with the neck and avoids unnecessary contact with clothing. Many patients, particularly the elderly, will be content with the relief which this operation provides and for them no further operative treatment need be contemplated. Younger patients, however, may find the wearing of a permanent tracheostomy tube irksome and request the alleviation of their disability by other means.

Nerve suture and nerve anastomosis

Nerve suture has been attempted and isolated successes have been recorded. In theory this should be the ideal treatment for restoring function to one or both damaged nerves, but almost all attempts have led to failure owing to technical difficulties such as the identification of the cut ends of this slender nerve, embedded as it usually is in dense scar tissue following the thyroid operation.

Ballance and Colledge (1927) carried out animal experiments to determine the possibilities of nerve anastomosis They found that in the monkey, end-to-side anastomosis of the recurrent laryngeal nerves with the phrenic nerve led to normal movements of the vocal cord on quiet respiration On killing the animal three years later, microscopical examination revealed complete recovery of the muscles and nerve concerned.

Barnes and Ballance (1927) performed this operation on a woman aged 52 years suffering from bilateral abductor paralysis after removal of an adenomatous goitre. Some return of movement was noted in one cord, abduction being about one-third of the normal The other cord was uninfluenced by the operation and remained fixed in the midline No other successes or partial successes following the operation of nerve anastomosis have been recorded, and the procedure has not established itself as a treatment for laryngeal paralysis.

Nerve section

Complete section of the damaged recurrent nerves to allow the cords to assume the cadaveric position of midway between abduction and complete adduction has been recommended, but the results have been uniformly disappointing. Section of the superior laryngeal nerve to relax the cords by paralysing the cricothyroid muscle has also been carried out, but without material improvement in the airway.

Excision of the vocal cords

Excision of the vocal cords by thyrotomy, or by per-oral methods, has also been attempted for the relief of bilateral abductor paralysis. Chevalier Jackson (1921) described the operation of ventriculo-cordectomy in which, by direct laryngoscopy, much of the vocal cord and floor of the ventricle on one side is removed with punch forceps; three weeks later the other side is similarly treated. Other surgeons preferred to open the larynx and to remove the vocal cord, as in the operation for intrinsic cancer. These operations failed because the raw granulating area in the larynx healed with the formation of a band of immobile scar tissue, which replaced the excised cord, with insufficient improvement in the airway and considerable impairment of the voice.

Ventriculectomy or ventricle stripping

This operation was originated by Williams (1906) for the treatment of recurrent nerve paralysis in horses In this animal it is relatively easy to evert and excise the laryngeal ventricle and sacculus. The resulting raw surfaces in the ventricle adhere together, and thus place the vocal cord in abduction. Hobday (1921) improved on this procedure by entering the larynx of the horse through the cricothyroid membrane and stripping out both ventricles at the same time. He suggested that this operation might be used in the human subject, but Vlasto and others showed that the human ventricle differs materially from that of the horse, so that eversion is impossible without causing damage to the laryngeal mucosa. For this reason Vlasto (1921) concluded that the operation was not practicable in man.

Anterior cordopexy

Detachment of the anterior end of one or both vocal cords from the midline, and fixation outwards to the lateral wall of the thyroid cartilage to enlarge the airway through the anterior part of the larynx was proposed by Moore (1923) after experimental work on the cadaver After splitting the thyroid cartilage vertically in the midline, a triangular piece of cartilage, to which the anterior end of the vocal cord is attached, is slid outwards along a horizontal incision through the thyroid ala for ¼ inch, leaving the cord anchored in a small circular opening in the alar cartilage at the outer end of the horizontal incision In this way a considerable gap can be created in the anterior half of the larynx with resultant improvement in the airway, although with almost certain deterioration of the voice. Musgrave Woodman (1924) reported the successful restoration of the airway by this method in a girl aged 15 years suffering from bilateral abductor paralysis following the removal of a thyroid tumour. He stated that the vocal cords remained in their newly-placed position.

Posterior cordopexy

Fixation of the posterior end of one cord in abduction has been described by Rethi (1934) The larynx was opened by laryngofissure after preliminary tracheostomy, and an incision made in the mucous membrane behind the upper part of the arytenoid and under the vocal process. The crico-arytenoid joint was opened and the attachment of the adductor muscles divided The arytenoid was displaced outwards and secured in this position by tamponage, thereby abducting the posterior end of the cord

Rebattu (1950) also opened the larnyx by laryngofissure and transfixed the vocal cords with sutures to the thyroid ala. In some instances he employed a suture anteriorly as well as posteriorly.

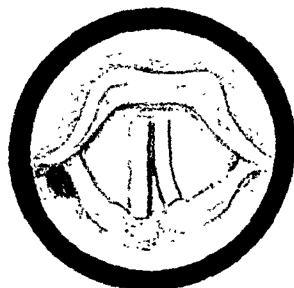
Extra-laryngeal route

This type of cordopexy was first described by King (1939) He believed that by an

extra-laryngeal approach to the crico-arytenoid joint an arthroplasty could be performed which would restore some power of abduction to the paralysed vocal cord. Although he soon acknowledged that, in fact, mobility did not return, he found that the outward displacement and external rotation of the arytenoid occasioned by his operation brought about sufficient improvement in the airway to allow the tracheostomy cannula to be discarded. Since King's publication, Kelly (1941), De Graaf Woodman (1949), Clerf (1950) and others have described similar procedures.

King's operation

Preliminary tracheostomy is carried out some weeks previously to avoid cough during convalescence. An incision 2½ inches in length is made through the skin and platysma along the anterior border of the sternomastoid muscle from the upper border of the thyroid cartilage to its inferior cornu. The omohyoid muscle is identified and divided ½ an inch below the hyoid bone. A ligature should be placed round the distal end of the muscle to help anchor the subsequent suture to the arytenoid. The posterior edge of the thyroid ala is defined and the fibres of the inferior constrictor muscles are divided along the line of their attachment. The pharyngeal mucosa is carefully separated away to expose the posterior surface of the cricoid and the arytenoid cartilage. The posterior crico-arytenoideus muscle is divided at its insertion into the base of the muscular process of the arytenoid and the crico-arytenoid joint is opened by dividing the joint capsule. After severing the insertion of the inter-arytenoideus and lateral crico-arytenoideus muscles, adequate mobility of the arytenoid is secured. The vocal process is encircled by a chromicized catgut suture which is passed through a drill hole near the posterior border of the thyroid cartilage level with the vocal process. The cut omohyoid muscle is then attached by another suture round the arytenoid At this stage the larynx is examined by direct laryngoscopy and the suture around the vocal process is tightened under vision until the required degree of abduction has been obtained. It is then tied over the edge of the thyroid ala leaving the arytenoid cartilage in a position of abduction and external rotation. King (1941) found that a minimum posterior gap of 3 millimetres is essential for the airway, but a maximum of 5 millimetres should not be exceeded if the voice is to remain good (Fig. 153). The wound is closed in layers with drainage. Since there was no return of mobility in the cord, King abandoned the use of the omohyoid attachment and contented himself with displacement of the arytenoid. In his cases the voice remained serviceable, the quality depending on the width of opening achieved.



Fi[illegible]

(By courtesy of the Editor of J. Laryng.)

Clerf (1950) adopted a very similar technique, and reported on 66 cases. The airway was satisfactory in all and the voice was reasonably good except in one case where it was reduced to a loud whisper.

King's method presents some difficulties, as the exposure obtained is somewhat limited.

Kelly's operation

Kelly (1941) claimed that by excision of the arytenoid cartilage extra room for respiration was provided after healing was complete To effect this removal the crico-arytenoid joint is approached through a window in the ala of the thyroid

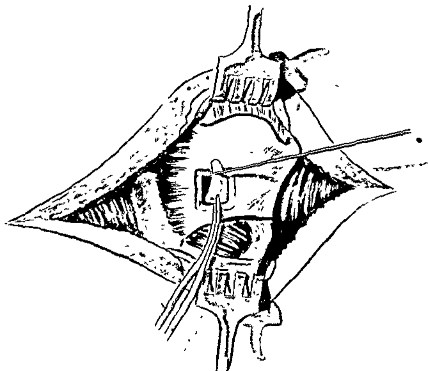


FIG 154—Kelly's operation. Freeing and delivering the arytenoid cartilage.

cartilage. For cosmetic reasons a horizontal incision is employed in a crease in the neck from the midline to the sternomastoid at the level of the lower border of the thyroid cartilage The pre-tracheal muscles are exposed and divided. A window $\frac{3}{8}$ of an inch square is made through the cartilage in the lower posterior third of the ala, bringing into view the attachments of the thyro-arytenoid and lateral crico-arytenoid muscles to the arytenoid cartilage The capsule of the crico-arytenoid joint is opened and by means of a hook the arytenoid is secured and dissected free of its muscular attachments (Fig 154) A catgut stitch is placed through the posterior end of the cord, great care being taken to keep the stitch submucosal to avoid the risk of sepsis and subsequent granuloma formation The arytenoid cartilage is lifted out through the window and the suture is secured to the external perichondrium to abduct the cord to the required extent; this is checked by examination through a laryngoscope. The divided muscles are sutured and the incision closed Considerable difficulties are encountered in Kelly's operation due to the small size and depth of the exposure. Bleeding is also troublesome, and may make accurate insertion of the suture a matter of great difficulty.

De Graaf Woodman's operation

While agreeing with Kelly as to the need for removal of the arytenoid, De Graaf Woodman (1949) prefers the wider exposure afforded by King's approach, but with some modifications. After preliminary tracheostomy he introduces an intra-tracheal tube, which facilitates identification of the arytenoid by pressing it outwards. After incising the fibres of the inferior constrictor muscles at their attachment to the thyroid ala, he separates the perichondrium on the mesial aspect of the ala sufficiently to free it of its attachment to the constrictor muscle. To widen the exposure the facet-like joint between the inferior cornu and the cricoid cartilage is then separated, and the superior cornu is cut through at its base. The perichondrium on the lateral wall of the cricoid is incised and the incision is continued vertically upwards until the crico-arytenoid joint is opened. The arytenoid is dissected free of its muscle attachments and is disarticulated and rotated outwards to expose the vocal process. A curved atraumatic needle threaded with chromic catgut is passed round the vocal process, care being taken to keep it in the submucosa and to include some fibres of the thyro-arytenoid muscle. All the arytenoid is then removed except for the vocal process. The suture is drawn laterally and tied around the inferior cornu, or if that is deemed to be too low, through a drill hole in the thyroid ala. The intra-tracheal tube is then withdrawn so that the degree of abduction can be inspected by laryngoscopy before the knot is tied. The wound is closed with drainage. De Graaf Woodman quoted 24 cases, of which 21 followed thyroid surgery. The voice was good in 13, adequate in 9 and worse in 2. The airway was satisfactory in all. The advantage of De Graaf Woodman's operation over both King's and Kelly's is the better exposure which permits the arytenoid to be more easily identified and the suture to be placed with more accuracy.

Arytenoidectomy

Although much used in horses by veterinary surgeons before it was superseded by the ventricle stripping operation, the first record of its adoption in man was by Ivanoff (1913). The patient was a syphilitic on whom tracheostomy had been performed for bilateral abductor paralysis of the larynx. The larynx was opened and unilateral arytenoidectomy was carried out but with only temporary improvement, as the stenosis soon recurred. The favourable results obtained in arytenoidectomy with cordopexy, however, has led to the revival of interest in this method of treatment, either by the laryngofissure route or by suspension laryngoscopy.

Arytenoidectomy by thyrofissure

Removal of the arytenoid by this route was recommended by Owen (1952) as affording the simplest access to the arytenoid. After removal of the cartilage, haemostasis is obtained by diathermy coagulation to the bed—which later promotes further abduction—before the mucosal margins are drawn together. Experience of 7 cases successfully treated in this way has convinced Owen that simple removal of the arytenoid is all that is required to restore the airway, and that outward traction of the vocal process is unnecessary.

Thornell's operation

Preliminary tracheostomy must be carried out. With suspension laryngoscopy an incision 1 centimetre in length is made over the superior surface of the arytenoid extending laterally on to the aryepiglottic fold. By submucous dissection the muscular attachments of the lateral surface of the arytenoid are separated. The superior portion of the arytenoid is then rotated laterally so as to facilitate separation on the mesial aspect by the means of a very sharp laryngeal knife. It is extremely important to avoid tearing or injuring the mucous membrane of the lateral wall of the larynx,

since scarring in this area would nullify the attempt to increase the glottic opening. After removal of the arytenoid a guarded electro-cautery point is deeply inserted along the course of the thyro-arytenoid muscle, beneath the vocal cord, and into the space previously occupied by the arytenoid cartilage. What little bleeding occurs is easily controlled by the cautery. The incision is closed with one suture. An acrylic obturator is inserted between the cords to keep them abducted and is anchored to the tracheostomy tube below and the cheek above; it is removed after 5–7 days. The tracheostomy tube can usually be corked in 2 weeks and left out after 3–4 weeks. This operation, to those accustomed to working with suspension laryngoscopy, presents certain advantages and is said to be gaining popularity in the United States of America.

Submucous excision of the cord and arytenoid cartilage

Hoover (1932) introduced the method of submucous excision of the vocal cord after opening the larynx by laryngofissure. His purpose was to avoid granulation tissue formation with subsequent contracture and scarring, by leaving an unbroken epithelial surface in the larynx to cover the thyroid ala in spite of free excision of the vocal muscles. Beginning anteriorly by sharp dissection, the mucous membrane above and below the cord is separated to a point below the vocal process of the arytenoid, particular care being taken not to tear the thin and adherent mucous membrane of the ventricle The soft tissues comprising the thyro-arytenoid and underlying lateral crico-arytenoid muscles are then separated from the thyroid cartilage and removed by means of fully curved scissors together with the vocal process of the arytenoid cartilage. The flap of mucous membrane is pressed into contact with the thyroid ala by means of a pack, the end of which is brought out through the cricothyroid membrane. The rest of the thyrotomy incision is closed. The pack is removed in 4–7 days and the tracheostomy tube in 1–2 weeks after preliminary corking of the

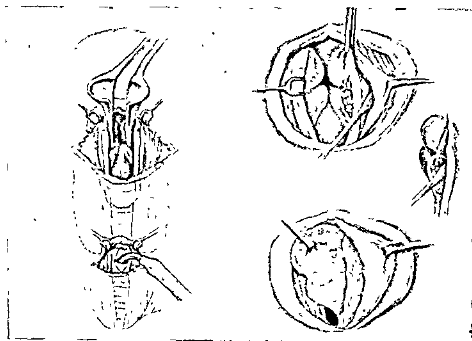


FIG 155—Tracheostomy and laryngofissure through separate collar incision. Submucous excision of alar cartilage.
(By courtesy of the Editor of the "Journal of Laryngology and Otology".)

tube. Hoover reported 4 cases in which the airway was good in all, the voice was good in 1 and impaired in 3.

Young (1955) has made certain important modifications in Hoover's operation For cosmetic reasons he employs two collar incisions, the lower being for the tracheostomy if that is not already present (Fig. 155). After splitting the thyroid cartilage vertically he elevates the perichondrium from the outer and inner surface of

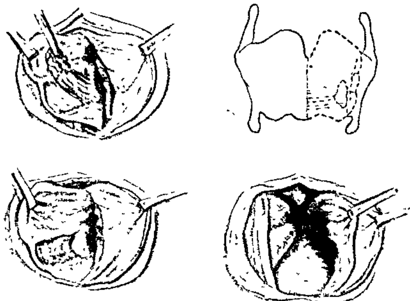


Fig. 156.—Stages in excision of musculus vocalis and arytenoid.
(*By courtesy of the Editor of the "Journal of Laryngology and Otology"*)

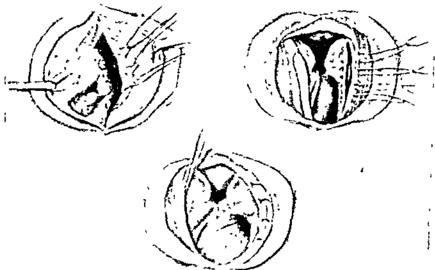


Fig. 157.—Method of obliterating cavity by mattress sutures.
(*By courtesy of the Editor of the "Journal of Laryngology and Otology".*)

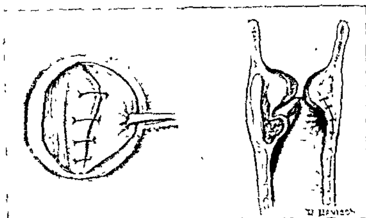


FIG. 158.—Final result of operation shown in Figs. 155-157.

the ala and resects the cartilage leaving only a narrow rim. He claims that this step, by eliminating denuded cartilage, promotes better healing, and, furthermore, that excision of this cartilage affords an extra 2 millimetres to the airway. Young states: "The musculus vocalis can then be isolated on the raw surface of the medial flap and peeled up like a sausage from before backwards as far as its insertion into the arytenoid (Fig 156) The whole arytenoid is resected with it and bleeding arrested by diathermy The resultant cavity is obliterated by mattress sutures and the larynx closed in the usual manner (Figs. 157 and 158)" Speech is forbidden for 1 week and then actively resumed under the direction of a speech therapist. The tracheostomy tube is discarded in 1-2 weeks after preliminary corking

Loré (1936 a and b) made a proposal, based on cadaver experiments, that after thyrofissure a horizontal incision be made through the mucosa along the length of the vocal cord, so that flaps could more easily be turned up and down to facilitate excision of the vocal muscles as well as the whole arytenoid cartilage. The two flaps are then accurately sewn together and the larynx closed as in Hoover's operation

Lawson (1955) has described a very similar technique. After opening the larynx he infiltrates the mucous membrane above and below the vocal cord with weak anaesthetic solution to raise it up, so as to facilitate its separation from the underlying structures An incision is then made along the whole length of the cord 1 millimetre above its edge A second similar incision is made parallel to the first 1 millimetre below the cordal edge. The mucous membrane is then elevated upwards and downwards and the cord and arytenoid excised (Fig. 159) After bleeding has been arrested the two flaps are accurately sutured together. No packs are used but the mucous membrane is fixed to the thyroid ala by several catgut mattress sutures The wound is then closed (Fig 160) Lawson states that while the voice may not be good following submucous excision of the cord, much can be done to help these patients by speech therapy. In all his cases the airway has been very good (Fig 161).

Choice of treatment

Some of the operations described are of historic interest only, and in general it can be said that the choice now lies between permanent tracheostomy, arytenoidectomy, with or without cordopexy, and submucous excision of the vocal muscle and arytenoid. Many authorities agree with Owen (1952) that arytenoidectomy has played the major part in the success of the King or De Graaf Woodman type of operation and they question whether the lateral abduction obtained by the suture-cordopexy

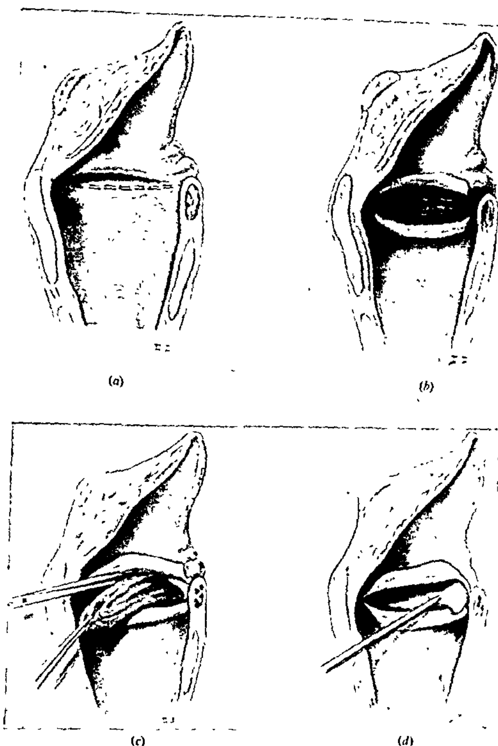


Fig. 159.—Stages of operation of submucous excision of vocal cord. (*a*) Lines of excision; (*b*) mucous membrane flaps raised; (*c*) thyro-arytenoid muscle being removed; (*d*) arytenoid cartilage being removed.

operation is of more than temporary duration. It is likely, therefore, that simple arytenoidectomy by thyrofissure or laryngoscopy may supplant the posterior extra-laryngeal approach. The width of the airway after a modified Hoover operation is likely to be greater than after arytenoidectomy, with or without cordopexy, and it is, therefore, the method of choice in more vigorous patients where the quality of voice is of less importance than freedom from obstruction. On the other hand, after

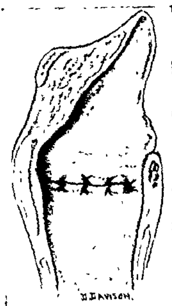


FIG 160.—Completion of operation of submucous excision of vocal cord. The final suture line of the mucosa
(By courtesy of the Editor of the "Journal of Laryngology and Otology")

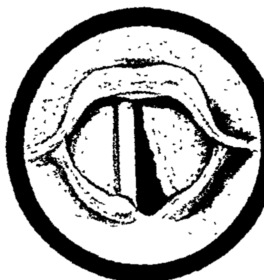


FIG. 161.—Larynx after a submucous excision left vocal cord, showing extent of airway (from actual case).
(By courtesy of the Editor of the "Journal of Laryngol... and Otology")

arytenoidectomy, with or without cordopexy, the voice will usually be m... satisfactory.

Finally, it cannot be disputed that, apart from its aesthetic disadvantag... tracheostomy with the incorporation of a flap-valve will satisfactorily overcome ... laryngeal obstruction without any further disturbance of the voice

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MELANOMAS AND THEIR SPREAD

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Terminology

The terminology of melanoblastic neoplasms is confusing since some authors refer to all forms as melanomas, using the adjective benign or malignant; others restrict the term melanoma to the malignant form and designate the benign a pigmented naevus or mole. The latter nomenclature will be adopted here.

MOLES AND MELANOMAS

Melanomas comprise between one and two per cent of the malignant tumours. The great majority are primarily visible on the surface of the body and consequently allow the patient an opportunity, unsurpassed in malignant disease, of seeking medical guidance early.

The origin of moles and melanomas has given rise to controversy; much recent work lends support to the view of Masson (1951) that the essential pigmentary dendritic [illegible] These [illegible] cell tumours and pigmented carcinoma in xeroderma pigmentosum. They may be imitated by warts, ulcerating haemangiomas, pyogenic granulomas and sclerosing angiomas (fibroma simplex, histiocytoma, dermatofibroma).

Differentiation

In differentiating the mole from the melanoma the following are the main clinical features which favour malignancy:

(*a*) Rapid growth in a tumour arising *de novo* or increase in size of a previously benign lesion. The enlargement may be mainly of a circumferential nature or as an elevation from the surface.
(*b*) Discharge—serous, purulent or haemorrhagic—from the mass.
(*c*) Alteration in colour, usually a deepening in the degree of pigmentation.
(*d*) Signs of inflammation.
(*e*) Increasing firmness in consistency or induration at the base.
(*f*) Subjective sensations, usually irritation or a dull pain.
(*g*) Related lymph-gland enlargement or the appearance of metastases.

In a series of 50 cases of melanoma a pre-existing mole was found in 33; in 18 of these a history was given of direct injury shortly before the appearance of malignant changes. The figures approximate those in large collected series.

Age Incidence

When allowance is made for the diminishing number of patients in the older groups it is found that the age incidence of melanomas increases from puberty. Before puberty the condition is rare; the juvenile or pre-pubertal tumour may present the microscopical features typical of a melanoma and yet the subsequent clinical course is likely to be that of a benign lesion.

During pregnancy

In pregnancy melanomas frequently undergo rapid dissemination The disease may or may not be transmitted to the foetus. Five years ago a patient was admitted in labour obstructed by melanomatous deposits in the pelvis. A live child was delivered by Caesarean section, the placenta being later examined histologically and found free of melanoma The patient died a few months later; her child remains well.

Mode of spread

Local spread

The behaviour pattern of melanomas resembles that of skin cancers generally. Nevertheless, certain differences exist and require emphasis.

In transplantation experiments it is a rule that tumours capable of metastasizing, and also the metastases themselves, are hetero-transplantable. That melanoma nodes often fail to grow when transferred to guinea-pigs suggests that the rules for transplantation do not all apply for melanomas (Greene, 1950)

Again, the period between the appearance of a primary melanoma and that of a metastasis is frequently outside the time limit usually found in other malignant cutaneous tumours This is most obvious in melanomas of the uveal tract where periods of up to 30 years may elapse between excision of the primary growth and manifestation of metastasis The mode of dissemination in malignant neoplasms is accepted as being by blood-stream metastasis and by extension within the lymphatic system; the spread of melanoma conforms to this pattern. A primary melanoma may, however, be associated with a solitary melanomatous nodule in a distant region of the body and removal of both foci has been followed by apparent cure. If the nodule is a solitary metastasis, it represents a manner of spread which occurs rarely in the dissemination of other forms of malignant disease.

Such variations in the behaviour of melanomas demand an added caution in assessing operability and prognosis. Five cases, recorded by Wainwright (1933) and by Pringle (1937), in which operations were conducted early in this century for melanomas with advanced regional lymphatic involvement, show, by survival times which range from 15 to 38 years, the wariness with which one should apply general rules for operability in neoplastic disease to the treatment of melanomas.

The malignant transformation of more than one pigmented naevus in an individual patient is extremely rare. This observation would seem to favour local factors being responsible for the change, despite some evidence pointing to the existence of hormonal influences in the subsequent growth and rate of dissemination of the melanoma

Whether malignant neoplasms of the skin arise from a focus in a bed of normal tissue or whether there is an alteration in the tissues locally which predisposes to the development of malignant change from multiple foci within the affected field remains controversial The former view arose from Cohnheim's hypothesis of embryonic cell rests and, although the main concept has been largely abandoned, some pathologists believe that malignancy may start in a single group of cells and the growth enlarge by intrinsic cellular proliferation without alteration of the surrounding tissues. Willis (1948) strongly opposes this view. He writes "what is to be insisted upon is that a skin cancer in its early formative phase arises more by a general transformation of pre-existing epidermis than by cellular multiplication and only after the formative field has all suffered neoplastic change does the tumour grow solely by multiplication. The two processes, neoplastic transformation and proliferation, overlap, the former predominating during the early genesis of the tumour, the latter often being initially negligible but gradually taking increasing and finally exclusive part in the growth of the tumour". The potentially malignant area may therefore be much greater than the extent of the contained primary tumour and its boundary indeterminable—an aspect

of major importance in formulating the extent of tissue removal needed for local eradication of the disease

The classical studies of Dawson (1925) lend support to the multifocal nature of neoplastic tissue origin in the field of melanomas. Early cellular changes were shown not only in immediate apposition to the edge of the melanoma but at a distance from it. On serial examination of large adjacent tissue areas isolated groups of cells undergoing malignant transformation were seen.

In this connexion a case reported by Van den Brenk (1954) is of interest. It concerns the development of melanoma in both recipient and donor sites of an autogenous skin graft.

> The patient, a male aged 68 years, developed a paronychia of the right thumb. The nail was removed but healing was defective and a graft was taken from the anterior surface of the right forearm and applied to the unhealed area of the thumb. Healing was still unsatisfactory and 9 months later the nail-bed and distal phalanx of the thumb were removed, a skin flap being thrown back over the dorsum of the digit. Healing followed but soon afterwards the patient noticed two dark spots in the thumb scar. The donor site also failed to heal, wart-like excrescences appeared and these later became dark in colour. The area was excised, it healed then broke down, dark rapidly-enlarging blebs appearing along the scar. At the same time the spots on the thumb grew and ulcerated. There was no apparent lymph-node involvement and no evidence of more distant spread. Interscapulo-thoracic amputation was performed, subsequent examination of the operation specimen confirming the tumour on both the forearm and the thumb to be melanoma. Both patient and surgeon asserted that no lesion was present at the donor site before the graft was taken. Although the forearm lesion grew more rapidly than that on the thumb, the delay in onset of macroscopic malignant progression was similar, being a period of about 9 months from the date of grafting.

Two inferences may be drawn from this case: first, it lends support to recent experimental work upon specific "initiation" and non-specific "promotion" in the genesis of malignant tumours, secondly, the trauma of grafting, at donor and recipient sites, was the initiating factor and the subsequent scarring process the promoting stimulus. Alternatively it is possible that a growing tumour exerts an inhibitory effect upon the remainder of the adjacent altered tissues and that in the quoted case operation included the removal of malignant or potentially malignant cells from the donor site with consequent reduction of local inhibitory processes.

Distant metastases

The next problem is that of spread from cutaneous melanomas Although it is accepted that extension is by the lymphatics and the blood stream, the exact mode of spread has not been fully elucidated. It is clearly a matter of great importance in formulating principles of surgical therapy

Pringle, in 1908, described what he believed to be an original method for operating upon skin melanomas, and his proposals were widely adopted: Grey Turner strongly supported the method of treatment.

The principles advocated were. (*a*) "To surround the primary growth with an incision as far removed from it as is judged to be necessary. (*b*) To run from the most convenient point in this generally elliptical or ovoid incision a second one along the normal course of the main lymphatic trunks as far as necessary to allow free removal of at least the nearest lymphatic glands. (*c*) To reflect the skin well back and to each side from these incisions, and excise the tumour with the whole of the subcutaneous tissue exposed containing the lymph vessels, the deep fascia of the limb and the fascia propria of muscles exposed along with the lymphatic glands in one continuous strip."

The inclusion of the fascia propria is worthy of emphasis as it has often been omitted in subsequent descriptions of the method. Pringle met three cases of melanoma during the course of his surgical work; one was considered inoperable, and two were treated

according to the principles which he later published. The first, a girl aged 17 years, presented with a melanoma at the flexure of the left elbow; the axillary glands were involved. The second, a man aged 30 years, suffered from a melanoma of the inner aspect of the left thigh, the inguinal glands were extensively infiltrated with melanoma. On reviewing these cases in 1937 both patients were shown to be alive and free from recurrence of growth, the first 38 years and the second 30 years after operation.

These spectacular cases overshadowed later, less successful, series. It was assumed that, by meticulous excision of the tissue-strip superficial to the fascia propria of subjacent muscles in a line from primary growth to related glands, the lymphatic channels likely to be invaded were extirpated. This presupposes a direct and superficial lymphatic course from the primary lesion. Dissections have been made of limbs, amputated because of melanomatous infiltration, in order to check this and the findings are that the lymphatic involvement may lie more deeply than the plane of deep fascia. One case was a male aged 69 years with an ulcerating melanoma on the medial side of the sole of the right foot, pigmented spots adjacent to the ulcer, a mass of enlarged inguinal glands and no evidence of wider spread, who was subjected to hindquarter amputation The limb was later dissected and 30 tissue specimens were removed for histological study. Of the glands examined the inguinal, external iliac and common iliac contained melanoma deposits: popliteal glands were not involved. Three skin specimens from skin areas near the primary ulcer were invaded and showed that skin involvement had occurred to at least 3 inches from the proximal edge of the lesion. In addition melanoma was identified in perivascular tissue immediately below the origin of the posterior tibial artery. Of the 12 specimens of deep fascia none was found to be the site of malignant infiltration.

A further example of this deep mode of spread was seen in a male aged 59 years for whom operation was performed for a melanoma on the dorsum of the right forearm with enlargement of the epitrochlear gland and also of a gland in the centre of the axilla. The primary lesion was removed with a wide margin of surrounding tissue. Through an incision extending from the anterior fold of the axilla to the medial epicondyle, the epitrochlear gland, the axillary glands and an intervening block of tissue deep enough to include the underlying perivascular elements were removed. Histological examination showed that the epitrochlear and axillary glands were invaded by melanoma although the latter were not macroscopically pigmented. In the perivascular tissue from a position 2½ inches proximal to the epitrochlear gland a dark nodule was identified and was later shown to be melanomatous, this was not surprising Gray (1946) describes the course of the lymphatic vessels passing across the medial side of the elbow as partly entering and partly by-passing the epitrochlear lymph glands. Both sets then pierce the deep fascia with the basilic vein and end in the lateral group of axillary glands or join the deep vessels The basilic vein pierces the deep fasica below the middle of the upper arm so that removal of a strip of deep fascia from elbow to axilla is not likely to result in extirpation of the lymphatic channels in that region.

In the lower limb a proportion of the lymph vessels from the superficial tissues pierce the deep fascia to course along major vascular trunks: below the knee these drain into the deeper popliteal glands and course upwards along the femoral vessels to the inguinal region Hence in both upper and lower limbs, particularly in the parts distal to knee and elbow, the lymphatic spread of melanoma to perivascular tissues beneath the deep fascia may be expected to occur. That it does so is seen in the two examples given and they indicate that the concept of complete removal of lymphatic vessels between primary growth and related glands by excision of a deep fascial strip is untenable except, possibly, in cases in which the primary growth is close to the lymphatic glands Further investigations are being made into this aspect of melanoma spread.

Melanoma may metastasize to any organ or tissue in the body. Bone metastases are rare; Geschickter and Copeland (1930) found them in 1·07 per cent of cases and a similar incidence was found by de Cholnoky (1941). The radiological picture of bone involvement is that of destruction and does not present specific features. Two examples are shown (Figs. 162 and 163), the first in the scapula of a male aged 56 years, and the second in the innominate bone adjacent to the sacro-iliac joint in a male aged 21 years. Both patients had advanced melanomatosis.

The final comment in considering the mode of spread of melanomas is that the spontaneous regression or cessation of growth in these tumours has been rarely recorded (Daland and Holmes, 1939, Willis, 1948). In 1955, Allen reported a most interesting case of spontaneous regression following pregnancy.

The patient, a female aged 37 years, was first seen in 1942. She complained of a pigmented lesion of the right forearm. This was excised and from its histological appearance was considered to be benign. Its nature was later reviewed and an opinion formed that it was a malignant melanoma. The following year a black nodule was seen in the scar and was excised, it was a melanoma. After a period of 10½ months, when in the seventh month of her fourth pregnancy, she presented with multiple bluish nodules subcutaneously on the left waistline, the right flank and the right upper arm. The last-named nodule was excised and found to be a lymph node almost entirely replaced by tumour. The prognosis wa thought to be hopeless. Seven weeks later, 14 days after the birth of a normal child, furth deposits had developed in the right scapular and inguinal regions together with localiz masses of undetermined character in the left breast. She was again seen 2 months aft wards and all the nodules seen at her previous attendance had disappeared with the exception of a small node in the right groin. In June 1955, 12 years after the appearance of the widely scattered deposits, she was found to be entirely well.

Treatment

Radiotherapy

In the past many methods have been advocated for the treatment of melanomas. Broadly, the number of cases in various series has been small and the results not confirmed by subsequent investigators. The largest group is that in which either radium or x-radiation has been used. In assessing results it is difficult to exclude accurately tumours of the epidermis, either squamous cell or basal cell cancers, which happen to contain pigment. These give far better results from radiotherapy than the generally radio-resistant melanoma. It is important to recognize the fallacy that diminution of the primary growth necessarily improves the patient's survival period. In some cases this form of treatment has been seen to cause intense irritation and tissue activity, the very reaction that is to be avoided. Pack and Livingston (1940) reported 217 cases o melanoma treated by irradiation; in 5 cases the tumour disappeared and in 41 it decreased in size. Ackerman and Regato (1947) found a favourable response to irradiation in only 2 per cent of cases. There is some evidence that, as an adjuvant in the alleviation of terminal pain and discomfort, irradiation may be helpful. Irradiation of the pituitary gland has not been proved to be of value.

Surgical treatment of melanoblastic tumours

This subject falls into two categories: (1) the prophylactic excision of pre-melanotic lesions; and (2) the surgical ablation of established melanoma.

Since each person has, on average, at least 20 visible pigmented naevi the advocacy of their wholesale removal is obviously impracticable, but those present on the body surface where they are subjected to repeated trauma should be excised. Examples are those of the scalp, the beard area and the hands, and those at sites where clothing or footwear may cause repeated friction as on the feet, ankles and pressure areas of the collar, braces, belt, brassiere or suspender. Urgent excision is to be recommended for



FIG. 162 —Secondary deposit of melanoma in right scapula. Male patient aged 56 years.

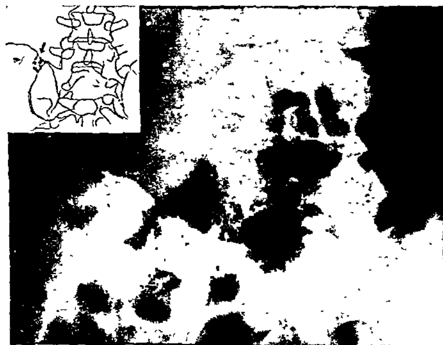


FIG. 163 —Secondary deposit of melanoma in the innominate bone. Male patient aged 21 years.

any pigmented naevus which may show changes indicative of melanomatous transformation—usually increase in size, alteration in colour, irritation, bleeding, serous discharge, infection, ulceration or enlargement of related lymph glands. Pigmented naevi of the palm, sole, scrotum, vulva and those in the region of the toe-nails and finger-nails should be regarded *with great suspicion.*

The malign effect of pregnancy has been emphasized and the surgical extirpation of moles which exhibit any suggestion of alteration together with those which are being subjected to repeated trauma should be advised as early as possible in the period.

Excision should be total and include macroscopically normal surrounding tissue; any form of partial removal is to be condemned. On the other hand a correct diagnosis of melanoma on clinical grounds alone is not possible except in the most advanced growths. Histological confirmation is essential in early cases and radical measures are not justifiable in the absence of such confirmation Ewing and Powell (1951) have drawn attention to this in comparing the clinical and pathological diagnoses of 123 pigmented tumours.

The surgical treatment of confirmed melanoma requires elaboration in the light of the foregoing observations. Radical measures are essential and the extent of these measures may be sufficiently great to provoke opposition on the part of the patient who regards the primary lesion, often small and causing no symptoms, to be of trivial import.

The following are considered to be the principles in surgical treatment of melanoma, all patients being previously carefully examined to exclude generalized metastases.

Extent of tissue excision

The primary tumour should be removed together with a wide margin of surrounding tissue. But how can this wide margin be defined? If—and there is good evidence to [illegible] altered that melanotic growth [illegible] be removed must remain [illegible] Indeed, the act of incising

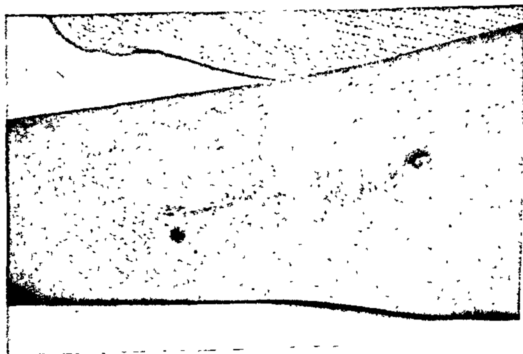


FIG 164—Melanoma nodules in scar following wide excision of a primary melanoma

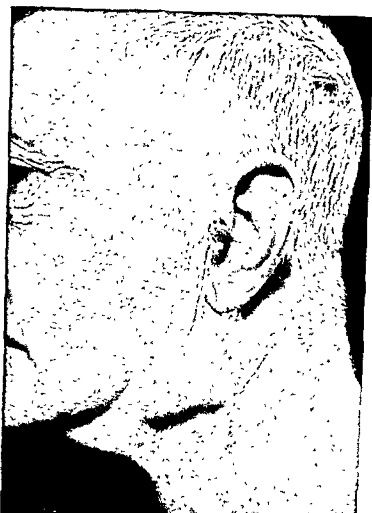


FIG. 165.—Melanoma of left ear with lymphatic gland metastases. Treatment consisted of wide circumauricular excision with block dissection of glands of neck on left side in continuity.

the inguinal ligament. A procedure whereby the anterior superior iliac spine is detached, the abdominal musculature incised vertically from the spine and the mass swung medially has been advocated. Division of the ligament and of the underlying femoral sheath, however, allows a thorough removal of perivascular tissues and has not been found hazardous from the viewpoint of post-operative weakness Lymphorrhoea following lymphatic gland resection may be troublesome in the axilla and more so in the groin where healing is often further delayed by necrosis of the skin edges and by mild infection A method of inguinal closure advocated by Lee (1955) (Fig 166) whereby a crescentic abdominal flap is rotated downwards to replace the defective tissues in the wound area has given good results.

Digital and subungual melanomas

Digital and subungual melanomas (Fig 167) should be treated by amputation of the digit at the metacarpo-phalangeal or metatarso-phalangeal joint with block dissection of the axillary or inguinal lymph nodes More conservative ablation of the primary tumour is likely to result in recurrence (Fig. 168).

Melanomas of the foot

Melanomas in the forepart of the foot, the toes excepted, are best treated by a Syme or Pirogoff amputation. Melanoma in the proximal part of the foot, including

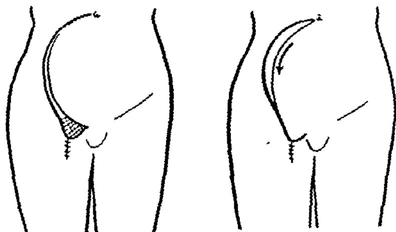


FIG. 166.—A method of filling the defect after block dissection of inguinal glands (after E. S. Lee)



FIG. 167.—Melanoma of thumb.



FIG. 168.—Recurrence of melanoma following inadequate local excision for primary melanoma of finger-tip

the heel, require amputation at the site of election in the lower leg with block dissection of the inguinal glands.

Oral melanomas

Melanomas of the oral cavity are treated according to the principles already enunciated. The post-operative fitting of a prosthesis may be necessary.

Anal melanomas

Melanomas of the anal canal require most radical treatment which should consist of abdomino-perineal resection of the rectum with bilateral iliac node excision, the wide peri-anal section being continued on each side to include both sets of inguinal glands

Melanomas of the genitalia

Melanomas of the genitalia should be treated by wide excision and bilateral inguinal block dissection in continuity.

Pre-pubertal melanomas

Pre-pubertal melanomas should be excised in the manner already advocated but removal of related lymph nodes is not performed as a routine since metastasis is exceptional.

Surgical treatment during pregnancy

The surgical treatment of melanoma in pregnancy is of the utmost urgency. The pregnancy should be terminated. Sterilization is not indicated since patients who have had melanomas adequately excised and have remained free of recurrence for several years have passed through subsequent pregnancies without recurrence of melanoma.

Nerve section

Palliative surgery has a place in the removal of a large fungating growth in the

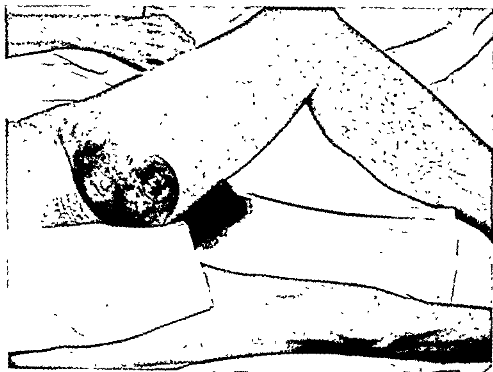


FIG. 169—Left inguinal and lower abdominal metastases causing severe pain, treated by dorsal chordotomy.

presence of general metastasis. Occasionally, nerve section is called for in the patient with inoperable melanoma who is suffering intractable pain (Fig. 169)

Late results

In spite of the poor prognosis when lymphatic glands are involved pre-operatively, there have been a number of recorded cases where apparently inevitable early death has not followed and hence a degree of optimism is required in order that hesitation is exercised in the labelling of a growth as inoperable unless general metastases are present. Pack and Livingston (1940) reported excision of a primary melanoma in the skin of the chest wall with axillary node dissection. In subsequent operations over a period of several years metastases were removed from the scalp, trunk, back, arms and opposite axilla. The patient was well with no further recurrence 10 years later. Wainwright (1933) reported excision of a melanoma overlying the right scapula with axillary gland involvement in 1905; in succeeding months metastatic tumours were removed from the left shoulder and opposite axilla, the melanomatous nature of all tumours being confirmed microscopically. This patient was well more than 27 years later. Pringle's 2 patients, both with gross glandular involvement initially, were well 30 and 38 years later.

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Obstruction of the pancreatic duct

The suggestion that obstruction of the pancreatic duct in an actively secreting gland might cause acute pancreatitis has been generally credited to Rich and Duff (1936) Obstruction may be due to inflammatory oedema, calculus, tumour, abscess, cyst, haematoma or, as they specifically suggest, squamous metaplasia in the ducts. Hess (1909), Wangensteen (1931), Lium and Maddock (1948), and Coffey (1952), among others have produced pancreatitis experimentally by combining ligation of the pancreatic ducts with stimulation of the gland. Carcinoma of the head of the pancreas may obstruct the pancreatic duct without the development of pancreatitis Cannon (1955) has ligated the pancreatic duct, thus destroying the exocrine function of the gland, in the treatment of recurrent pancreatitis.

Vascular theory

The view that acute haemorrhagic pancreatitis may have a vascular component in its aetiology is not new. Panum (1862) produced haemorrhage into the pancreas by injecting small particles of wax into the pancreatic arteries. Langerhans (1890), Lépine (1892), Bunge (1903), and Smyth (1940) have all induced experimental pancreatitis by [illegible] experimentally that oedematous pancreatitis can be transformed into the haemorrhagic type by temporarily occluding the pancreatic arteries.

An autopsy on one of our patients who died from multiple emboli in a case of mitral stenosis revealed haemorrhagic pancreatitis in the distal half of the pancreas produced by an embolus lodged in an artery to the gland. This would appear to be a case of acute haemorrhagic pancreatitis in which ischaemia was the initiating factor.

Adams and Musselman (1953) have postulated thrombosis of pancreatic veins as a cause of haemorrhagic pancreatitis rather than a result. By ligation of the veins at various sites and the injection of either topical thrombin or lyophilized trypsin they created a thrombosis in the vein and a pancreatitis in the portion of the pancreas involved. Acute interstitial pancreatitis may suddenly be converted into a fulminating haemorrhagic or necrotic pancreatitis by the development of venous thrombosis. Levels of trypsin, amylase and lipase are high in the pancreatic vein in acute pancreatitis The trypsin, being proteolytic, converts prothrombin to thrombin and causes blood coagulation

Thal (1955) noted the similarity between the rapidly developing vascular lesions seen in the dermal Schwartzmann reaction and that of acute haemorrhagic pancreatitis. He perfused the pancreatic ductal system of rabbits with either meningococcal or *Escherichia coli* endotoxin. All ductal injections were performed well below the pressure required to produce ductal rupture. Rapid diffusion of the bacterial toxins through the intact ductal wall was repeatedly observed. Twenty-four hours later the local Schwartzmann reaction was induced by intravenous injection of the same toxin. All rabbits were ill within 3 hours and all died in from 4 to 24 hours after administration of the challenging dose. Death in these animals was due to acute haemorrhagic pancreatitis.

In controlled experiments, where either the sensitizing dose or the intravenous provocative dose was omitted, pancreatic necrosis failed to occur in all animals By examining tissues from animals sacrificed at varying intervals following the provocation of the local Schwartzmann reaction in the pancreas, it became clear that venous and capillary thrombosis regularly preceded the pancreatic necrosis and haemorrhage. We have all seen similar lesions in human autopsy material. The findings of Thal (1955) are obviously important in relation to the disease in man by indicating a mechanism whereby toxins or micro-organisms present in the bowel or upper gastro-intestinal

tract may sensitize the pancreatic blood vessels. Schwartzmann has shown that the vascular lesion is readily produced in such sensitized tissues by the presence in the systemic circulation of a number of biologically unrelated substances. Meningococcic toxin and toxins from *E. coli, Proteus*, and *Salmonella typhosa* will all produce the same phenomenon. All of these organisms may occur in the upper reaches of the duodenum in which they or their products may perfuse the biliary and pancreatic systems.

Trauma

Acute pancreatitis may follow trauma, such as gun-shot wounds, stab wounds, crush fractures or injuries from automobile steering wheels. Operative procedures such as choledochostomy or gastrectomy for a posterior wall penetrating ulcer may be followed by pancreatitis. The overall mortality rate for post-operative pancreatitis is in the vicinity of 50 per cent. In 12 cases in our hospitals 7 proved to be fatal.

Miscellaneous

The frequent association of pancreatitis with acute and chronic alcoholism is well known The mode of action may be that of obstruction of the pancreatic duct in an actively secreting gland. Alcohol stimulates acid secretion in the stomach and the subsequent increase in acid chyme in the duodenum causes hypersecretion of the pancreas by the action of secretin. The duodenitis which accompanies prolonged ingestion of alcohol may produce obstruction by initiating spasm of the sphincter of Oddi Menguey (1955) has carried out some very interesting unpublished studies in experimental pancreatitis He demonstrated that alcohol introduced into the duodenum causes a rapid rise in the resistance of the pancreatic and biliary sphincters and a concomitant marked rise in intra-pancreatic duct pressure. The rise in pancreatic duct pressure after alcohol was greater when alcohol was introduced into the duodenum following a meal. A significant rise in biliary pressure occurred only in cholecystectomized animals.

The production of acute pancreatitis by the administration of ethionine in the diet of animals has been reported (Kalser and Grossman, 1954) Ethionine is an analogue of the amino acid methionine and it is antagonistic to methionine. It produces pancreatic necrosis and insufficiency with a damaging effect on enzyme manufacture and release This work stresses the importance of the availability of adequate protein in the prevention of pancreatic damage and insufficiency (Bockus, 1954). The chronic alcoholic invariably suffers from dietary insufficiency and lack of available protein. This mechanism may provide the relationship between alcoholism and pancreatitis.

The spread of infection from the gall-bladder by lymphatic or ductal routes, mumps, and hepatitis are also included among the causes of acute pancreatitis.

CLINICAL ASPECTS

In our own experience with acute pancreatitis 30 per cent of patients were classified as acute haemorrhagic pancreatic necrosis. The remainder were classified as acute oedematous pancreatitis This latter group might well have been misdiagnosed prior to the advent of the serum amylase estimation. The youngest patient in our series was aged 20 years; the eldest 84 years. The average age was 50 years. There were 56 males and 41 females in the series of 97 cases of acute pancreatitis The incidence of associated gall-bladder disease varied from 25 per cent in males to 50 per cent in females. It should be emphasized that radiological examination of the gall-bladder carried out during the acute attack of pancreatitis is not reliable. If, however, the examination is repeated 7–14 days after the acute episode the gall-bladder will often visualize normally.

In the typical case of acute haemorrhagic pancreatitis the patient frequently after

eating or over-indulging in alcohol is seized with severe, sudden, agonizing pain in the upper abdomen. The pain is often steady, occasionally colicky, and radiates to the back and to the flanks. Nausea and profuse vomiting follow in the wake of pain. Tenderness with minimal upper abdominal rigidity is present, but is noted later than in other lesions producing an upper abdominal catastrophe. In our series 1 patient was moribund on admission, 4 fulminating cases went on to expire 2-5 days after admission to hospital in spite of very energetic supportive treatment including blood transfusions, antibiotics, and in several cases ACTH and cortisone. We are inclined to agree with Kirby, Howard and Rhoads (1955), who have recently said that there is little we can do to reverse the disease process in acute fulminating pancreatitis. The severity of the clinical picture appears to vary directly with the degree of the pathological changes found in the pancreas. Ileus, abdominal distention, and fever, to be followed later by a localized abscess in the upper abdomen, is the usual course of the patient with a necrotic lesion who survives the initial catastrophe.

Our experience with the serum amylase estimation has made us feel that it is very dependable. We have reported a study of serum amylase activity as determined in approximately 400 consecutive surgical patients pre-operatively and post-operatively In all cases the blood for estimation of the enzyme was taken before sedatives were administered in order to avoid an elevation of amylase activity associated with spasm of the sphincter of Oddi incident to pre-operative medication. Occasionally other abdominal conditions such as a perforating or penetrating ulcer may also exhibit high serum amylase determinations making differential diagnosis difficult. No test should be regarded as infallible and it is necessary to appraise each abdominal emergency carefully, re-examine and re-evaluate the patient frequently, if we are to avoid the error of withholding operation in patients in whom it might have been life-saving.

A scout film of the abdomen may be of value. In our series 25 per cent of the cases demonstrated a segmental ileus. Diabetes mellitus was present in 3 patients at the time of admission, 2 of whom had previous attacks of pancreatitis. Diabetes developed in an additional case as a sequel to the attack of acute pancreatitis. Tetany, owing to the lowered serum calcium level, may develop on rare occasions on the fifth or sixth day, in only 1 patient in our series it occurred shortly before death on the fifth day of the disease.

TREATMENT

Prevention or reduction of pancreatic enzyme production

If the diagnosis can be definitely established, a conservative regime should be followed. The prevention or reduction of pancreatic enzyme production is one of the prime aims in therapy Acid in the intestine causes liberation from the intestinal mucosa of the hormone secretin which stimulates pancreatic secretion via the bloodstream. This explains the prompt secretion of pancreatic juice from the passage of acid chyme into the duodenum. It has more recently been shown that peptones, proteoses and some of the products of digestion of fat which are present in the intestine are pancreatic secretagogues. They produce a secretion rich in nitrogenous material. This mechanism may be explained by the liberation of pancreozymin, a hormone which is derived from the intestinal mucosa and stimulates the pancreas to secrete a juice rich in enzymes. The pancreatic gland has a special nervous mechanism which regulates the discharge of enzymes, and which seems to have little relation to the secretion of the liquid parts of the juice; this mechanism is controlled by the vagus nerve.

The importance of secretion of enzymes in initiating pancreatic injury in the presence of duct obstruction, or in aggravating the insult produced by reflux or vascular occlusion, cannot be over-estimated Nasogastric tube aspiration and the withholding of fluids and food by mouth are first principles in the treatment of acute pancreatitis

The tube should be placed in the pre-pyloric portion of the stomach, in an effort to prevent any gastric content proceeding into the duodenum.

Supportive therapy

In addition to pancreatic rest, supportive measures are of great importance. Zollinger, Keith and Ellison (1954) have been very interested in the blood volume deficits in patients with acute pancreatitis. They have used radioactive iodinated human serum albumin to measure the blood volume in these patients. In general they have found a definite fall in the plasma volume as well as some fall in the red cell mass in the majority of patients with acute pancreatitis. They have been treating these patients with blood and serum albumin and feel that restoration of sufficient plasma volume is the effective agent rather than the antitryptic effects of these substances as has been suggested by Kenwell and Wels (1953) Elliott and his colleagues (1955) have induced pancreatitis experimentally by retrograde injection of bile into the pancreatic ducts which ordinarily has resulted in death of the animals. They found, however, that dogs will recover from this experiment if a sufficient amount of serum albumin is administered. They are of the opinion that the efficiency of the albumin is not due to its antitryptic effect but rather to the replacement of deficient plasma volume.

Regardless of the mechanism by which blood or albumin produces its beneficial effect it suffices to say that the seriously ill patient suffering from acute pancreatitis requires intensive supportive therapy including blood and blood substitutes.

Attention has been directed to the dangerous degree of hypochloraemia and hypocalcaemia which may occur in pancreatic necrosis Electrolyte levels must be controlled by frequent blood estimations and prophylactic administration Caloric needs can be met by intravenous glucose or invert sugar. Carbohydrate metabolism must be carefully managed and insulin coverage is mandatory because either hypoglycaemia or hyperglycaemia will stimulate pancreatic secretion (Babkin, 1950)

Control of pain

To control pain Demerol is probably the drug of choice and should be used intravenously if the patient is in shock. Nitrites, such as amyl nitrite, have their place in treatment in the absence of shock. The relief of sphincter spasm and resultant pancreatic duct decompression may dramatically relieve the pain and modify the severity of the attack. Atropine is effective in reducing enzyme output and counteracting spasm of the sphincter of Oddi which usually accompanies the use of opiates. Epidural procaine blocks have been used successfully in the alleviation of pain. The effect of the block on the course of the disease is unknown The beneficial effect of hexamethonium bromide, a ganglion-blocking agent, has been reported recently but results from its use have been variable.

Antibiotic therapy

The antibiotics have been credited not only with reducing the mortality of the disease but also with markedly reducing the complications of acute pancreatitis. Abscesses have responded well to antibiotic therapy. Five of 7 cases in one series cleared under antibiotics without drainage (Hay, 1954). Kirby, Howard and Rhoads (1955) believe that antibiotics and adequate supportive measures may prevent many deaths from infection and secondary [illegible]

[illegible]

as variable as acute pancreatitis.

Surgical treatment

Surgical treatment was carried out in 25 patients with acute pancreatitis in our series. Most of these cases were acute upper abdominal emergencies in which the

diagnosis of pancreatitis could not be made pre-operatively and in which it was considered more serious to overlook a perforated or gangrenous viscus than to perform a laparotomy on a patient with pancreatitis. Three cases showed a progression of the associated cholecystitis and one a deepening jaundice. If operation is performed adequate drainage of the fossae should be carried out along with cholecystostomy if the gall-bladder is present. In the absence of biliary-tract disease Baker and Boles (1955), despite lack of belief in the efficacy of decompression, still favour cholecystostomy routinely by means of a Pezzar catheter. Such a catheter, besides providing decompression, is useful for post-operative cholangiography. Of the patients operated on later in the course of the disease, 50 per cent were subjected to an operative procedure on the biliary tract. In the remainder of this group the pancreatic area was the primary site of the operative procedure The indication for operation was the presence of pseudocyst or a residual lesser sac collection.

Definitive operations are required for the treatment of abscesses. The latter will increase in frequency as more cases of severe pancreatitis survive the initial attack. When pancreatitis and cholecystic disease occur together elimination of gall-bladder disease very frequently prevents further attacks of pancreatic disease. Early operation may prevent the serious late manifestations of recurrent pancreatitis.

RECURRENT OR RELAPSING PANCREATITIS

Recurrent or relapsing pancreatitis can best be defined as that entity in which acute and subacute attacks of pancreatitis recur with varying frequency, usually with freedom [illegible] each attack the [illegible] develops in the necrotic areas. Atrophy is often marked, but occasionally at operation the pancreas may be slightly enlarged and oedematous

The progressive pathological changes in the gland are usually accompanied by recurrent clinical episodes In rare instances, however, fibrotic lesions of the pancreas may be found [illegible] exhibit wasting, steato [illegible]

The most likely cause of relapsing pancreatitis appears to be some form of obstruction associated with hypersecretion of the pancreas. It seems unlikely that trauma, vascular abnormalities, or virus infections are often the cause of the relapsing form of the disease.

Medical management by diet, antispasmodics, anticholinergics and sedatives has been unsuccessful in the control of the recurrent form of pancreatitis. Chronic alcoholism and drug addiction have been frequently reported. Some patients may be [illegible] improved if the alcohol intake is curtailed [illegible] operation. [illegible] n of associ- [illegible]

[illegible] In 1950 a female aged 21 years was admitted with severe epigastric pain [illegible] from the acute [illegible] ated serum [illegible] ally during amylase content. The gall-bladder was [illegible] her first hospitalization, but later examinations revealed the presence of stones. She was readmitted and at the time of cholecystectomy the pancreas was found to be slightly enlarged, firm and oedematous. The common bile-duct was not explored because it was small and did not contain calculi. She has been well since the cholecystectomy was performed.

Elimination of cholecystic disease is usually sufficient to produce relief from further attacks of pancreatitis and it is this group of cases that affords the best results

At the time of cholecystectomy, if the common bile-duct is dilated and the pancreas hard and fibrotic, operative cholangiography should be carried out followed by mmon duct exploration. Cholangiograms may demonstrate residual stones in the ict.

Case 2. *S.P.*: In 1952, a male aged 50 years was admitted to the University Hospital with recurrent episodes of epigastric pain. His gall-bladder had been removed 10 years before for gall-stones; there was no history of subsequent jaundice. His serum amylase was markedly elevated on several occasions and a diagnosis of recurrent pancreatitis was made. At operation the head of the pancreas was hard and slightly enlarged An operative



Fig 170—Operative cholangiogram demonstrating residual common bile duct stones causing recurrent attacks of pancreatitis

cholangiogram revealed the presence of calculi in the common bile-duct which had not been palpable (Fig 170) The duct was explored and the stones were removed; the sphincter of Oddi was dilated easily to 7 millimetres with Bakes' dilators, T-tube drainage of the common bile-duct was continued for 3 months. He has been free from recurrent attacks since the time of his operation.

Prolonged T-tube drainage aids in decompression of the biliary tract and has been reported upon favourably by the Mayo Clinic group in the treatment of the recurrent pancreatic lesion When the tube is removed, however, the same conditions prevail as prior to its insertion and it is difficult for us to rationalize this form of therapy in this disease

The operative cholangiogram may also aid in ascertaining the tone of the sphincter of Oddi In the presence of spasm of the sphincter reflux of dye into the pancreatic duct may be demonstrated

Case 3 *M R* In 1951, a female aged 59 years was admitted to the University of Alberta Hospital complaining of recurrent attacks of epigastric and right upper quadrant pain

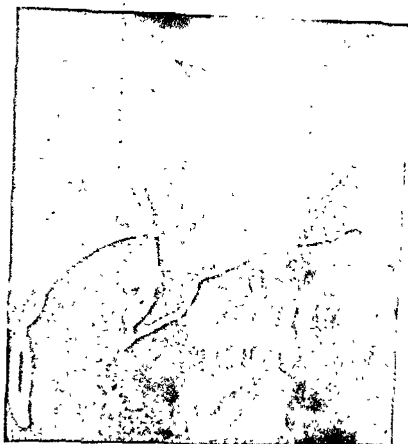


Fig. 171.—Reflux of opaque medium into pancreatic duct due to sphincter spasm

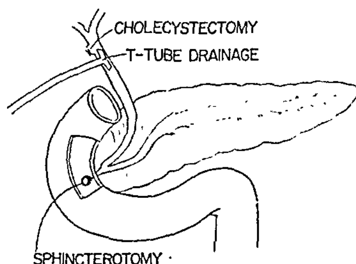


Fig. 172—Diagrammatic representation of sphincterotomy in *Case 3 Previous choledochostomy had failed to relieve recurrent* attacks of pancreatitis.

She had had cholecystectomy performed 20 years before for cholelithiasis. Serum amylase determinations on this admission were markedly elevated. At operation the pancreas was found to be hard and nodular. Common bile-duct exploration was carried out and T-tube drainage instituted. A cholangiogram was performed by injecting dye through the T-tube and it showed a reflux of dye into the pancreatic duct (Fig. 171). The T-tube was left in place for 4 months and soon after its removal the pain recurred. In 1953 the patient was re-explored; the pancreatic disease was more marked and a trans-duodenal sphincterotomy was performed to relieve spasm of the sphincter of Oddi (Fig. 172). The T-tube was removed in 6 weeks and the patient has been free from recurrence of pain since the time of the last operation.

It is evident to us, from a review of this case, that the post-operative cholangiogram demonstrated sphincter spasm and that a sphincterotomy should have been carried out at the time of the 1951 procedure.

Over 30 years ago Archibald (of Montreal) made original fundamental and clinical observations on the importance of sphincter spasm as the cause of pancreatitis and carried out sphincterotomy in the treatment of the recurrent lesion. Doubilet and Mulholland (1951) have continued the work of Archibald and have been enthusiastic about sphincterotomy in the relief of relapsing pancreatitis If the sphincter of Oddi cannot be dilated readily at operation a trans-duodenal visualization of the ampulla is indicated Doubilet (1955) has advocated the use of amyl nitrite at the time of exposure of the ampulla to demonstrate release of spasm and thus differentiate spasm from stenosis

Case 4. *M J.* In 1950, a female aged 43 years was operated upon for obstructive jaundice due to calculous obstruction of the common bile-duct After removal of a calculus, the sphincter of Oddi was dilated to 8 millimetres with Bakes' dilators. At the time of operation, the pancreas was noted to be hard and nodular. T-tube drainage during the next 2 months afforded relief and the T-tube was removed. The patient remained well for a period of 2 years before developing recurrent episodes of epigastric pain with an elevated serum amylase. She was finally readmitted with jaundice. At operation trans-duodenal exploration revealed a stenotic scarred ampulla of Vater. A side-to-side choledocho-duodenostomy was carried out (Fig. 173). The jaundice cleared and she has been free from pain since that time.

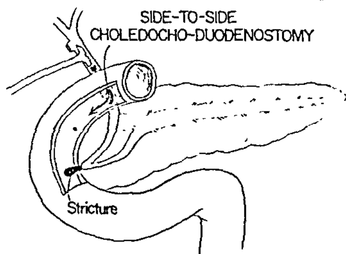


FIG 173 —Choledocho-duodenostomy to relieve the stenotic obstruction to the sphincter of Oddi. Previous sphincter dilatation had failed to relieve recurrent attacks of pancreatitis.

Sphincterotomy or sphincter dilatation is less effective in the treatment of fibrotic stricture of the sphincter of Oddi than it is in the treatment of spasm because in the former lesion scar contracture tends to recur. *Some short-circuiting* or decompressing procedure, such as a cholecysto-jejunostomy or side-to-side choledocho-duodenostomy, is more satisfactory than sphincterotomy. The Roux-Y type of anastomosis *reduces the risk* of cholangitis and Bowers (1951) claims that the danger of stricture is not great in good hands. Most surgeons hesitate to transect the common duct for any condition less than malignancy and prefer a side-to-side choledocho-duodenostomy to decompress the biliary tract.

Small pancreatic cysts in the head of the gland may cause obstruction of the pancreatic duct and *recurrent attacks of pancreatitis.*

Case 5. *R.R.:* In 1949, an alcoholic aged 43 years was admitted to the University of Alberta Hospital with a history of recurrent bouts of epigastric pain. An increased serum amylase was a constant finding with the attacks. He was found to have cholelithiasis and the gall-bladder was removed. At the time of operation the common duct was normal but the pancreas was hard and nodular, the common duct was drained. The patient was well

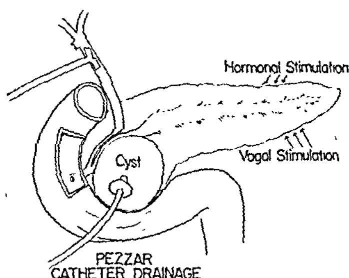


FIG 174.—Cyst in pancreatic head causing obstruction to secretory flow of pancreas relieved by *Pezzar* catheter drainage

[illegible] months the attacks recurred. He [illegible]

head obstructing the duodenum. A *palliative gastro-enterostomy* [illegible] and the mass subsided with *the aid of antibiotics and supportive measures* The pain continued and 6 months later he was re-explored A cystic mass, 5 centimetres in diameter, was found in the pancreatic head. The cyst was drained by means of a Pezzar catheter (Fig 174) and the gastro-enterostomy *was taken down as the* duodenum was no longer occluded He continued to drain for many weeks but finally healed completely, and has been free from attacks since the last operation, in spite of the continued use of alcohol.

Drainage of small cysts of the pancreas by a Pezzar catheter is simple and *effective.* Cysts of the body and tail may also be treated by excision of the distal portion *of the gland if cysts are small.* Marsupialization or *anastomosis* to stomach or jejunum (Puestow, 1953) may also afford decompression and drainage.

It has been previously mentioned that fibrotic lesions of the pancreas may be encountered without demonstrable *clinical findings*

Case 6. *S.H.:* In 1949, an elderly patient was admitted to the University of Alberta Hospital with painless jaundice, anorexia, and weight-loss. Pre-operative diagnosis of a

malignancy of the pancreatic head or ampulla of Vater was made. At operation biopsies from the superficial portion of the hard mass in the pancreatic head revealed only inflammatory changes. Biopsy of the regional lymph nodes and a needle biopsy of the central portion of the mass also failed to reveal malignancy. Anastomosis between the normal gall-bladder and the jejunum relieved the symptoms completely and the jaundice cleared

Incisional biopsies of the pancreas are dangerous. Injury to a major duct may allow liberation of trypsin-rich fluid and result in a haemorrhagic pancreatic necrosis; needle biopsy is safer. Smith (1953) describes a trans-duodenal biopsy either with a

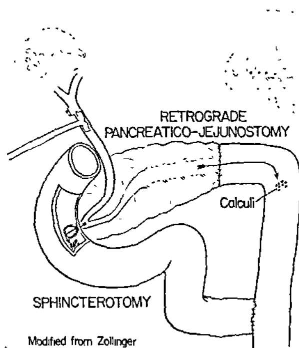


FIG 175—Retrograde pancreatico-jejunostomy by Roux-Y combined with sphincterotomy
(Modified from Zollinger, 1955)

diathermy or with an ophthalmic trephine. We have found that diathermy distorts the microscopic picture. A radical Whipple type of operation has occasionally been carried out on this type of lesion, suspecting cancer, only to find that the patient had been subjected to extensive surgery for a benign lesion

In the absence of biliary-tract disease and lacking evidence of obstruction of the sphincter of Oddi, the pancreatic duct must be explored for evidence of obstruction. Coffey (1955) explores the pancreatic duct at the time of trans-duodenal sphincterotomy and by using a polyethylene catheter has irrigated the pancreatic duct. The use of opaque medium through the catheter is useful in detecting residual calculi. If a calculus should remain in the duct and not be removed by irrigation Priestley (1952) has described a procedure for opening the duct, removing the stones and closing the duct over a T-tube, which is removed at a later date.

Du Val (1954), Zollinger (1954), Aird and Buckwalter (1955), and others have all been interested in the retrograde drainage of an obstructed pancreatic duct by means of a pancreatico-jejunostomy This may be accomplished either by end-to-side anastomosis of the pancreas to jejunum, or by an end-to-end anastomosis of the pancreatic duct to jejunum by a Roux-Y (Fig 175) At the time of this anastomosis the distal end of the pancreatic duct can be probed to remove residual calculi and afford a free flow of pancreatic juice in a retrograde direction

Longmire (1955) reports a case of retrograde decompression of the pancreas in which the changes of relapsing pancreatitis were found in aberrant pancreatic tissue. In this case, during re-exploration, trans-duodenal injection showed the entire duct to be patent. This patient had relief after the main duct was ligated, destroying the exocrine function responsible for the disease.

Cannon (1955) has described the successful use of ligation of the pancreatic duct in the treatment of this disease, *preserving* the endocrine function of the pancreas. The procedure is technically difficult by use of the trans-duodenal or extra-duodenal route and often not successful if the duct of Wirsung alone is tied.

Splanchnic blocks, by procaine or alcohol, give relief for an indefinite period of time.

Bilateral dorsal sympathectomy has proved effective in the control of pain which has become intractable. Failure of dorsal sympathectomy to relieve pain in advanced cases may be explained by the involvement of somatic nerves. Grimson (1955) has reported successful long-term follow-up of 9 cases treated by the removal of the celiac ganglia.

Case 7. *S.B*. In March 1952, a male aged 47 years was admitted to the University of Alberta Hospital with epigastric and right upper quadrant pain. A cholecystectomy had been carried out elsewhere one year previous to admission. The gall-bladder was normal on pathological examination. He had many recurrent episodes of pancreatitis with marked elevation of serum amylase and his pain was intractable. He required a large amount of sedation and was considered to be an addict. At operation the entire pancreas was hard, nodular, and fibrotic, and sphincterotomy was carried out with no relief. Subsequent radiological examination of the pancreas demonstrated diffuse calcifications throughout the entire pancreatic substance. In October 1952 a bilateral thoraco-lumbar sympathectomy and splanchnicectomy was performed, and the patient has since been free from pain and has had only one febrile episode 6 months after operation.

Partial or total pancreatectomy is of value in the presence of numerous small cysts, parenchymal calcification, gross destruction of the normal architecture, and in patients with persistent pain, in contrast to the intermittent pain seen in the early phase of relapsing pancreatitis. In our opinion a limited resection of the body and tail of the pancreas is a justifiable procedure, but total pancreatectomy should be used only when all other measures have failed.

Gastric resection combined with vagotomy has been recommended in the treatment of recurrent relapsing pancreatitis. The object of the procedure is to diminish pancreatic secretion.

SUMMARY

Acute pancreatitis may be secondary to biliary-tract disease since the latter is associated with pancreatitis in many cases. Alcoholism is associated with a considerable number of pancreatic lesions.

The clinical importance of acute pancreatitis is out of proportion to its frequency because it must always be considered in the differential diagnosis of acute upper abdominal disease. The serum amylase estimation is more important than any other laboratory procedure in the investigation of these patients.

If the diagnosis can be definitely established it would appear that a conservative regime should be followed. Early and vigorous supportive treatment is effective and essential as part of this conservative regime. After the initial shock has been treated it is obvious that it would be far more serious to overlook a perforated or gangrenous viscus than to perform laparotomy in a case of acute pancreatitis. If operation reveals an acute pancreatitis, cholecystotomy, or choledochotomy if common duct obstruction is present, should be performed with as little manipulation as possible. In the absence of biliary tract disease the rationale of biliary tract drainage is open to question.

Definitive operations are required for the treatment of abscesses. The latter will increase in frequency as the more severe cases of acute pancreatitis survive the initial attack.

When pancreatitis and cholecystic disease occur together the elimination of the gall-bladder disease very frequently prevents further attacks of pancreatic disease.

It would appear that recurrent attacks of pancreatitis are frequently associated with some form of obstruction to the active secretory flow of the pancreas. The case histories presented serve to illustrate the variety of lesions which may produce recurrent pancreatitis.

It is our opinion that it is unwise to depend on any one procedure to treat all patients We must attempt accurately to establish the aetiological factors present and select the operative procedure indicated in the individual patient.

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PART III ABSTRACTS

ADHESIONS AND CICATRICIAL STENOSES

See also B.S.P., Vol. 1, p. 72, S. Key 9.

Duodenum

Obstruction distal to ampulla of Vater

Symptoms and treatment.—Gray and Garrett (1955) have reviewed 68 cases in which duodenal obstruction occurred distal to the ampulla of Vater. Many of these cases had undergone previous operations for their symptoms without being relieved The commonest symptoms were abdominal pain and vomiting. In a considerable proportion the symptoms resembled those arising from gall-bladder disease In 34 cases the obstruction was due to a growth; in 13 it was due to pressure of the superior mesenteric vessels. Of these 13, 9 had experienced vomiting, and many stated that they were much improved while the stomach was empty Duodenojejunostomy was performed in 37 of the series, including all the cases with obstruction due to the mesenteric vessels. Of these 13, 11 had complete relief, 1 has only been followed for a month, and 1 appears to be hypochondriacal. One case was outstanding in that pre-operative x-rays demonstrated the site of the obstruction, and revealed that the duodenum was enlarged to the size of the stomach The authors point out that many [illegible]
the majority of [illegible]
normal They c[illegible]
explored, and fo[illegible]
particularly of t[illegible]
performed.

Gray, H. K., and Garrett, C. M , Jnr (1955). *Ann. Surg* , 142, 532.

ADRENAL GLANDS

See also B S P , Vol. 1, p. 94, S Key 12.

ACTH, cortisone and hydrocortisone in surgery

Therapeutic benefits and dangers

Need for further studies—Abbott, Krieger and Levey (1955) write on the therapeutic benefits and dangers associated with the use of ACTH, cortisone and hydrocortisone in surgery In those patients who have acute or chronic adrenal insufficiency as a result of disease or surgical extirpation of the adrenal glands the use of cortisone or hydrocortisone is mandatory. This group includes patients subject to total adrenalectomy in treatment for Cushing's syndrome or in palliative treatment of metastatic carcinoma of the breast and prostate Pituitary and adrenal suppression resulting in adrenal insufficiency is also observed [illegible]

[illegible] these hormones can be of value in producing dramatic remissions in cases of ulcerative colitis, haemolytic anaemia, thrombocytopenia and others when the need for surgical intervention is considered The use of ACTH, cortisone or hydrocortisone in many patients may be of value in avoiding operation, improving the pre-operative status of certain desperately ill patients, or relieving some of the post-operative complications. The function of these hormones in the treatment of peritonitis, infection and shock is not yet clearly established. In burns and surgical shock and in patients with severe or fulminating infections adrenal cortical extract, ACTH, cortisone and hydrocortisone have been reported as of great value, however [illegible]

induced. The availability of cortisone ar[illegible] or total adrenalectomy a relatively saf[illegible] ment of patients subjected to subtotal [illegible]

should be remembered that when given to surgical patients they can produce a wide variety of responses, many undesirable. More studies are needed before such compounds can be widely used for some of the conditions for which they have been advocated.

Abbott, W. E., Krieger, H., and Levey, S. (1955). *Ann. intern. Med.*, 43, 702.

Neuroblastoma in childhood

Surgical management

Koop, Kiesewetter and Horn (1955) give an account of the surgical management of [illegible]

spinal canal. All patients who were free of metastases at operation have survived. No patient with metastases in the [illegible] lymph nodes was com[illegible] marrow films. The sur[illegible]

[illegible] not necessary to carry out radical removal of viscera but to remove as much of the tumour as is practicable.

Koop, C. E., Kiesewetter, W. B., and Horn, R. C. (1955). *Pediatrics*, 16, 652.

ANAESTHESIA—GENERAL

See also B.S.P., Vol. 1, p. 205. S. Key 26.

Induced hypothermia

Advantages and dangers

[illegible] by Scurr and Gray (1955). It is pointed [illegible] value in the surgical treatment of thyro- [illegible] nd in operations on patients with aortic [illegible] the hypothermic state cardiac activity and [illegible] agulation time is increased. Furthermore, [illegible] harmful bacterial and enzyme activity is [illegible] dangers must be considered. For instance, [illegible]

dissociation curve is shifted to the left. [illegible] anaesthetic agents. Hypothermia may also cause bradycardia [illegible] warming period when [illegible] al experiments indicate [illegible] sthesia and that the [illegible]

is induced with *d*-tubocurarine chloride, 30 milligrams, and thiopentone, 150–200 milligrams. Maintenance of anaesthesia is by means of nitrous oxide and oxygen. An electrode from a

which open heart operations were performed

Scurr, C. F., and Gray, T. C. (1955). *Proc R. Soc. Med.*, 48, 1077.

Controlled hypothermia

Indications and results

Procedure described—Swan and his colleagues (1955) have analysed the results of controlled hypothermia in 100 cases in which the technique was used as an aid to operation. The principal indication for its use was the need for a bloodless field during temporary interruption of the blood supply to or through the organ. A low temperature prolongs the time that tissues remain undamaged by ischaemia. In cyanotic heart disease, the patient may have a normal pulse and appearance at a temperature (rectal) of 30° C. The blood pressure also falls with the lower temperature, making evaluation of the patient's circulatory state difficult, and increasing the risk of post-operative haemorrhage. For safety, hyperventilation is necessary, and for open cardiac surgery, the authors consider a right auricular blood *p*H of over 7 5 to be desirable in order to minimize the risk of ventricular fibrillation Fibrillation is also more likely because the hypothermia selectively depresses vagal function, and to offset this neostigmine was used intra-aortically during cardiac procedures To prevent air embolism in such cases, the authors fill the wound with Ringer's solution and close the heart incision beneath the surface of this To obtain hypothermia, the anaesthetized patient has a rectal thermometer inserted, and a transfusion of saline in his arm He is then placed in a bath of cold water, shivering being stopped by relaxants As his temperature starts to fall, ice is added to the bath, and on reaching 31° C the anaesthetic can usually be stopped The patient is removed from the water before the lowest temperature is reached, a fall of about two-thirds the range of that obtained during immersion being finally obtained. He then has a diathermy coil placed around his abdomen, and electrocardiographic leads or needles are affixed During operation blood is replaced as it is lost Before wound closure the patient is warmed by diathermy until he has an adequte blood flow and pressure. Complications of the method included 18 cases of ileus, 24 with pulmonary disorders, and 12 who developed peripheral neuritis The average stay in hospital post-operatively was under 11 days, except for a few cases with mild heart failure and 8 who received burns during re-warming Fourteen deaths directly related to the hypothermia occurred, 11 of these being due directly or indirectly to ventricular fibrillation Eight patients died from unrelated causes Of the 14 related deaths, only 3 deaths occurred in females, although about equal numbers of the two sexes were operated on Cardiac complications varied in the ease with which they could be rectified Cardiac standstill responded well to thoracotomy and manual compression Of 15 with ventricular fibrillation, only 5 were considered to have died directly from this cause, although only 3 were long-term survivors, the others dying from haemorrhage or heart failure The presence of previous myocardial disease seems to predispose to fibrillation, those with normal muscle being far less likely to fibrillate. The authors conclude that the method is of sufficient safety to warrant its further application, although more research is necessary into some aspects of the technique.

Swan, H , Virtue, R. W., Blount, S. G., and Kircher, L. T. (1955). *Ann. Surg.*, 142, 382.

Caesarean sections and vaginal deliveries

Use of thiopental

Several reports have recently advocated the use of thiopental (Pentothal) for caesarean sections and vaginal deliveries McKechnie and Converse (1955) report the results of an investigation to determine whether a specific placental barrier exists to thiopental to

section under spinal anaesthesia, a single dose of 350 milligrams of a 5 per cent solution of thiopental was given just before the delivery was deemed imminent and the time recorded.

ether, another Demerol 100 milligrams 2 hours prior to delivery, whilst the third infant had the umbilical cord wrapped twice round its neck. There was no correlation between the degree of depression in these infants and the concentration of thiopental in their cord blood, nor between the maternal depth of anaesthesia, foetal responsiveness and the thiopental concentration in the mixed cord and maternal blood. For vaginal deliveries, thiopental should be restricted to a single minimum dose administered during the last few minutes before delivery, whilst for caesarean section, it should be limited to the induction period.

McKechnie, F. B., and Converse, J. G. (1955). *Amer. J. Obstet. Gynec.*, 70, 639

ANGINA PECTORIS

See also B.S.P., Vol. I, p. 259, S. Key 30.

Stellate ganglion block

The anatomical approach in stellate ganglion block is discussed by WALLS (1955). Study of the anatomy of the stellate ganglion shows that the sympathetic trunk lies deeply in the neck, and that an anterior or lateral approach must pass close to important structures in the root of the neck,
the plane of the bracl
any approach, and t
subclavian, or inferior thyroid vessels, or, particularly in the posterior approach to the
pleural irritation occurs
inal fluid
k of the
rolateral
neck may
occurrence;
e one with
fewest serious complications, but the posterior route may be more satisfactory when much alcohol is to be injected, or when the block includes thoracic ganglia lower than the stellate.

Walls, W. K. J. (1955). *Brit. J. Anaesth.*, 27, 616.

ARTERIES

See also B.S.P., Vol. I, p. 327, S. Key 37.

Aneurysm of abdominal aorta

Surgical treatment

vascular disease
aortic aneurysm
of the aorta and
s of the various
should
on patients with
have, on the
been
teric
tulas

Rob, C. (1955). *Ann. R. Coll. Surg. Engl.*, 17, 307.

Ruptured aortic aneurysm

Surgical treatment

Five cases described.—SHUMACKER and KING (1955) discuss the surgical treatment of ruptured aortic aneurysm. Five cases are reported. The first, a man of 70 years of age, in whom a large abdominal aortic aneurysm had previously been reinforced, presented with violent abdominal pain and circulatory collapse. The perforated aneurysm was excised. No

and grafting produced excellent results. Operation on the third patient revealed large aneurysms of the abdominal aorta and right iliac artery, the latter being completely thrombosed. A graft was inserted and good circulation was maintained in the left leg, but death from uraemia supervened. In the fourth patient, operation and recovery were successful.

maximum importance. Although internal wiring and other procedures are undoubtedly palliative, they cannot prevent rupture and, even where leakage is slight, immediate surgery is indicated.

Shumacker, H. B., Jnr, and King, H. (1955). *Arch Surg, Chicago*, **71**, 768.

Aneurysm of the renal artery

Removal without nephrectomy

PITKANEN (1955) describes a case of a man of 43 years operated on for a suspected tumour

right rib due to trauma from which the aneurysm had resulted. The most conclusive evidence of true aneurysm was the histological structure of the tumour wall, which was identical with

pain experienced in the patient's side when walking. This assumption was also supported by the pre-hydronephrotic condition of the right kidney demonstrated by all the roentgen examinations.

Pitkanen, A. (1955). *Acta chir. scand.*, **110**, 232.

Aortic embolism

Treatment by embolectomy

arterial pulsation below Poupart's ligaments was found to be absent and there was complete loss of power and sensation below the knee in the right leg and slight loss in the left. About 5½ hours after the occurrence, the abdomen was opened and an embolectomy performed

returned to the right foot, but there is still residual weakness of the dorsiflexors and evertors. Lumbar sympathectomy might have obviated the development of the deep venous thrombosis if the patient's condition had allowed.

Basu, A. K., and Das, A. (1956). *Brit. Heart J.*, **18**, 126

Aneurysm of right axillary artery

Ligation of third part of subclavian artery—collateral circulation

ATKINS and JOSEPH (1955) review the collateral circulation following ligation of the third

uncontrollable axillary haemorrhage occurred. The third part of the right subclavian was ligated. Nineteen years later, the patient died from oesophageal carcinoma. On dissection, the axillary artery appeared normal in size. The first branch, which was additional, passed upwards to anastomose with the scapular vessels. The superior thoracic and acromio-thoracic arteries were enlarged, taking part in a thoracic anastomosis. The subclavian artery, of normal size, ended blindly deep to the scalenus anticus; from it, a vessel passed upwards and laterally, the lower of its two large branches traversing the posterior cord of the brachial plexus and joining the axillary artery on its posterior aspect. Several branches of the sub-

Atkins, H. J. B., and Joseph, J. (1955). *Guy's Hosp. Rep.*, 104, 380

Renal arteriography

Dangers

failed in both legs, so open insertion of the cannula was performed on the right leg, using 70 per cent Umbradil as the injection mass. Four hours later the patient went into shock, which responded to a transfusion, but which left the patient with signs of arterial occlusion in the right leg. There being no response to spasmolytics, sympathetic block was advised. During the early stages of general anaesthesia for ... At autopsy, a femoral thrombus was present. The kidney s...

Landelius, E. (1955). *Acta chir. scand.*, 109, 469.

ARTHRITIS—SURGICAL CONSIDERATIONS

See also B.S.P., Vol. 1, p. 371, S. Key 38.

Osteochondritis dissecans

Following ankle injuries

Necessity for x-ray of talus.—Osteochondritis dissecans has been described in many joints, particularly the weight-bearing joints, but has rarely been reported in the talus. DR GINDER ... the initial cause of injury in each case ... there was a quies- ... and at this time ... he carried out a ... a further 9 cases ... until severe joint damage had occurred. Every case with an original flake fracture ... its developed the ... removal of the necrotic chip of bone underlying the cartilaginous ...

DeGinder, W. L. (1955). *Radiology*, 65, 590.

Arthrodesis of the hips

Avoidance of post-operative complications

... high incidence of pseudo- ... (1956) says that ... for the shaft acts as a lever on the head at a great mechanical advantage ... movement of the

this leverage, the author
the hip. After a Smith-
ge iliac cortical graft is
e pubic ramus, and the

case has the desired position not been maintained by the single hip spica. The author concludes that the method has a higher incidence of successful union than those not employing osteotomy, and has allowed much earlier ambulation

Thompson, F. R. (1956) *J. Bone Jt. Surg*, 38A, 13.

AUTONOMIC NERVOUS SYSTEMS: ARTERIES

See also B S.P., Vol 1, p. 466, S Key 45.

Posterior upper thoracic sympathectomy

Improved method of approach

Difficulties encountered—An improved approach for posterior upper thoracic sympathectomy is described by MacKay (1955) He notes that in several methods of approach it is inevitable that the large upper back muscles have to be divided and separated and that much rib and an entire transverse process also need removal. Difficulties also occur in dealing with intercostal muscles and fascia, the pleura and the intercostal neurovascular bundles. The writer considered the advantages of a more direct approach by a limited upper dorsal costotransversectomy made possible by a midline exposure as for laminectomy.

ganglion or the second or third dorsal ganglion

MacKay, H. J (1955) *J Amer med. Ass.*, 159, 1261.

BLADDER—TUMOURS

See also B S.P, Vol 2, p. 140, S Key 58

Carcinoma of the urachus

Case report

at the apex
cyst-formation, lipoma and abscess in the space of Retzius.

Wright, H B, and McFarlane, D. J (1955). *Amer. J. Surg*, 90, 693.

Treatment

Cobalt-bomb radiation

by Br
Beam
of co
The

The great advantage of cobalt-bomb radiation is that only 2 gamma rays are emanated, these are of almost identical wave lengths, so that there is not the scatter which occurs with a powerful x-ray unit with a broad spectrum of emanation. As the maximum effect of the rays is about 6 millimetres below the skin, reactions were negligible. The series comprised 45 men and 13 women, aged 39–88 years: the duration of symptoms varied from 1–60 months; the tumours were transitional-cell in 33 cases, papillary in 11, squamous-cell in 8, and anaplastic in 6. A series of 34 patients were given palliative therapy, 3,000–4,000 roentgens in 3–4 weeks, and 24 received radical therapy, 5,000–6,000 roentgens in 3–6 weeks; the results were encouraging in both groups. The author makes the following recommendations: irradiation should not be earlier than 3 weeks after bladder opening to expose or biopsy the tumour; the urine should be examined at least twice weekly during therapy; and attempts should be made to reduce necrotic tissue and clear up the urine with antibiotics.

Busby, S. M. (1955). *Canad. med. Ass. J.*, 73, 872.

Reimplantation of ureter

BURNS (1955) reports a case of reconstruction of the lower ureter by a tube made from bladder flaps. Damage to the ureter commonly follows radical pelvic surgery in women. The earliest use of the bladder in pelvic reconstruction was described by Boari (1894) in an operation on a dog. The latest ureteroplasty (Higgins, 1953) ingeniously preserves the ureteral orifice but is applicable only to unilateral lesions. The author presents an involved repair in a case of advanced damage to both kidneys. A married woman aged 30 years had a 4-months history of erosion of the cervix. Biopsy revealed a squamous-cell carcinoma. Intravaginal cone therapy preceded the Wertheim operation. A month later, she had nausea, vomiting, and pain in the left lower quadrant. Urology revealed a large, palpable cystic mass on the left side of the pelvis, extending above the symphysis. Cystoscopy showed 200 millilitres of residual urine and a mass pushing the bladder medially. The author suspected complete obstruction of the left ureter and a large collection of extraperitoneal urine in the pelvis. A milder obstruction was apparent on the right side. Laparotomy revealed a large cavity containing 200 millilitres of clear, straw-coloured urine lateral to the bladder. The ureter was necrotic or obstructed as far as the uretero-vesical orifice. Exposed at the point of obstruction it was 1 centimetre in size and reasonably dilated. A 7-centimetre gap remained between the viable end and the nearest portion of the bladder. To bridge this, a tapering tongue of bladder was brought up to form a tube into which the end of the ureter was laid, fish-mouthed and sutured. The broad tongue was approximated after insertion of a drainage tube. Two weeks later, urological investigation was satisfactory. Catheterization of the right ureter recovered 45 millilitres of urine; a pyelogram showed angulation and dilatation. The patient was discharged but 5 weeks later a small mass was felt in the right pelvis; on readmission it was hard and larger. Excretory urography showed no function on the right side and obstruction of the ureteral orifice. Operation revealed complete ureteral obstruction at the pelvic brim; above this, it was dilated and tortuous; below, semi-necrotic and gangrenous. A similar surgical procedure was carried out on the right side, but 12–15 centimetres of ureter had to be replaced. After 3 months, the urine was clear and the mass had completely disappeared.

Burns, R. A. (1955). *J. Urol.*, 74, 348.

Infiltrating carcinoma

Treatment

Nylon tube sutures containing radioactive cobalt.—VERMOOTEN and MAXFIELD (1955) describe the treatment of infiltrating carcinoma of the bladder by means of nylon tube sutures containing radioactive cobalt. The treatment is indicated when it is difficult to remove the growth completely. With reference to the technique, a lead-shielded container is employed in order to protect the operating team against irradiation. The sutures should be placed in parallel rows at intervals of 1 centimetre so that the tumour is irradiated from edge to edge. Large tumours are reduced in size by means of a high-frequency cutting loop until the combined thickness of the carcinoma and bladder wall measures less than 1 centimetre. Thus the needle with the nylon suture can be passed through the tumour and the invading cells become exposed to the maximal intensity of radiation. An indwelling catheter is inserted with a balloon attached to it. The balloon can be inflated in order to keep the normal bladder mucosa away from the source of radiation, and it is important to note that premature deflation of the balloon may give rise to radiation cystitis. The radioactive material can be used repeatedly, for it has a half life of 5¼ years. Furthermore, the gamma radiation is homogeneous and most of the beta radiation is filtered by the nylon. After the appropriate dosage has been delivered the patient is given sodium pentothal and the sutures are removed. As there is little ionization of the tissues a soft flexible scar results.

Vermooten, V., and Maxfield, J. G. S. (1955). *J. Urol.*, 74, 767.

BONES—NEW GROWTHS

See also B S P., Vol 2, p. 298, S. Key 69.

Incidence of malignant cells in bone-marrow aspirations

Primary source

BERKHEISER (1955) reports the incidence of malignant cells in 246 routine consecutive bone-marrow aspirations performed in 241 patients mainly for the diagnosis of various types of anaemia Malignant cells were demonstrated in both bone-marrow smears and

malignant cells, but in the carcinoma of the colon, sections of marrow-clot showed well-formed acini and glandular structures which were not apparent in the cover-slip preparations In 5 of the cases (prostate, stomach and bronchus), it was only possible to state that

skeletal system before extensive surgery is attempted

Berkheiser, S W. (1955) *Cancer, N Y*, 8, 958.

Osteogenic sarcoma

Incidence, sites, spread and treatment

Series of cases reviewed—CADE (1955) discusses osteogenic sarcoma, the only malignant tumour derived from bone or bone-forming tissue, and histologically correlated to the spindle-shaped-cell unit The stroma may contain giant cells, fibrous tissue, cartilage or, rarely, blood vessels The presence of cartilage has led to a clinical distinction between primary and secondary chondrosarcoma, the latter developing in a long-standing benign growth and occurring in older patients. Malignant growth in or near bone produced widely different x-ray appearances. This relentless disease, however, shows great similarity in age, incidence, primary sites, mode of spread and usually fatal issue It occurs more often in

intramedullary spread is important in assessing amputation level Pulmonary metastases are usual Small, spherical, x-ray shadows at first, they increase in number and size with

traumatic "fibrositis" is unwarrantable X-ray confirmation by "Codman's triangle", "sun-ray spicules", "onion-peel" layers of new bone must not be awaited; biopsy should not be delayed Treatment has long been amputation, or occasionally, misguided local

many cases, and a few were spared amputation

Cade, Stanford (1955). *J.R. Coll Surg. Edinb*, 1, 79.

Benign giant-cell tumour of femur

Metastasis to lungs

GREGORY and WRIGHT (1955) record a case of benign giant-cell tumour of bone, which. 8 years after it had been first recognized, became malignant and metastasized to the lungs.

characteristics of a malignant giant-cell tumour of bone, Grade III in Jaffe's classification. Amputation was performed, following deep x-ray radiation; 18 days post-operatively the patient developed signs of infarction, but improved clinically. On re-admission, 3 years later, metastasis to the lungs had developed, and death occurred several months later. Examination of the pulmonary metastases showed that they were anaplastic giant-cell tumours similar histologically to the primary malignant neoplasm of the femur; they did not resemble osteogenic sarcoma. Possible causes of the malignant transformation of the tumour are thought to be inherent malignant tendency, lack of attempt to remove the neoplasm when it was first discovered, and the effect of irradiation.

Gregory, A. R., and Wright, A. W. (1955). *N.Y. St. J. Med.*, 55, 3269.

Liposarcoma in the femur

Case report

DAWSON (1955) writes on liposarcoma of bone and describes the case of a woman aged

as to

vish,

fat-positive tumour tissue inside the bone where the structure was frankly lipomatous, though showing considerable pleomorphism and mitotic activity, the whitish appearance of the prog

pointed to

criterion of

sarcoma cel

Examinatio

examination pointed to a primary tumour of the femur. No other distant primary growth could be found before operation; the possibility of a primary tumour being unobserved while producing advanced secondary femoral deposits seems unlikely. Both the history and the histology pointed to the view that the femur was the genetic focus. The carcinogenic factor

some part in general, but here the

blood-borne stimulus to neoplasia, can be admitted

rarity of bone liposarcomas without throwing any light on their carcinogenesis.

Dawson, Edith K. (1955) *J. Path Bact*, 70, 513.

BRAIN—ABSCESS

See also B.S.P., Vol. 2, p. 323, S. Key 71.

Otitic origin

Treatment by otological approach

LITTEL (1955) describes a case of brain abscess of otitic origin in a girl aged 8 years treated successfully by the otological approach and states that with precautionary

1 centimetre in diameter, was electrocoagulated and painted with iodine

incision made in the centre. An aspirating needle, introduced in a medial and superior direction encountered the abscess at a depth of 2·5 centimetres. Radical mastoidectomy was completed 6 weeks later and there have been no sequelae.

Littel, J. J. (1955). *Arch. Otolaryng., Chicago*, 62, 636.

BRAIN—INJURIES AND COMPLICATIONS

See also B S P., Vol. 2, p. 349, S. Key 74.

Posterior fossa haematoma

Case reports

GROSS (1955) reports one case each of posterior fossa haematoma in the extradural space, subdural space, and in the substance of the cerebellum Case 1, a man aged 20 years, fell from a truck and was knocked unconscious He was found to have a slight scalp abrasion just above the inion and a bilateral positive Babinski After 2 hours, he became semi-conscious but was restless The cerebral spinal fluid was grossly bloodstained and under pressure. After some improvement during the next few hours, he suddenly became cyanotic and died. At post-mortem examination, a linear fracture from above the inion to the foramen magnum, a large extradural clot over the right cerebellar hemisphere and pole of the right occipital lobe, and a tear in the right lateral sinus were found Case 2, a woman aged 51 years, was admitted to hospital complaining of back and lower extremity pain of 4 months' duration, and occipital headache and staggering to the left of 4 weeks' duration. Early papilloedema and nystagmus on left lateral gaze were present. At operation, a chronic subdural haematoma was removed from over the right cerebellar hemisphere with subsequent alleviation of her symptoms Case 3, a man [illegible]
complained of [illegible]
home, he coll[illegible]
size of a golf [illegible]
patient showe[illegible]
of posterior fossa haematomas will increase as the awareness of their occurrence increases.

Gross, S. W. (1955) *J Mt Sinai Hosp*, 22, 286.

Head injury

Delayed complications

SEDZIMIR (1955) describes six cases of carotid thrombosis and hemiplegia occurring as a delayed complication of head injury Analysis of the cases suggested that thrombosis of the internal artery took place as a result of trauma to the intracranial segment, and in the two cases examined after death a fracture of the floor of the anterior fossa was found in close proximity. In all cases the main impact was frontal. In the clinical progress of some head injuries a patient, after a lucid interval, may show deterioration in the conscious level, accompanied by the onset of focal signs Exploration for massive intracranial haemorrhage may prove negative The diagnosis made may be one of post-traumatic apoplexy or thrombosis of the middle cerebral artery or one of its branches, particularly if the patient is elderly The commonest site of internal carot[illegible]

carotid thrombosis.

Sedzimir, C B (1955) *J. Neurol. Psychiat*, 18, 293

Extradural haemorrhage

Mortality rate

Measures for reduction —SCHNEIDER and TYTUS (1955) recommend that a number of measures should be adopted in order to reduce the high mortality rate in patients with [illegible]

massive haemorrhage. One consideration must be given to the possibility that a supratentorial haemorrhage may extend into the posterior fossa Moreover, a head injury may produce an associated lesion such as subdural haematoma, and an extradural haemorrhage

may be due not only to injury but also to erosion of a blood vessel by otological or rhinological infections. Operative problems may influence the mortality rate. For example, if adequate exposure is not obtained with sufficient rapidity it may be difficult to identify the origin of the haemorrhage. As for the findings during the course of the operation, if the brain tends to bulge on opening the dura further trephine holes should be made for evidence of associated lesions.

Schneider, R. C, and Tytus, J. S. (1955). *Ann. Surg.*, 142, 938.

BRAIN—VASCULAR ANOMALIES

See also B.S.P., Vol. 2.

Aneurysm

Intracranial aneurysm

Treatment.—WHEELER (1955) describes a case of intracranial aneurysm in a woman aged 53 years. The patient complained of severe headache and blindness in the left eye. Angiography revealed a large aneurysm of the left internal carotid artery. Ligation of the left common carotid artery was carried out and two months later a similar operation was performed upon the left internal carotid artery. Although recovery took place loss of vision persisted in the left eye Employment of angiography in a series of 104 cases of intracranial aneurysm led to 4 fatalities. The aneurysm was revealed in only 79 cases. With regard to the management of aneurysm of the supraclinoid portion of the internal carotid artery Wheeler recommends ligation of the carotid vessels in the neck, but a direct intracranial operation should be performed when the aneurysm is situated more peripherally. The direct approach was adopted in 31 of 117 cases and there were 6 deaths in this group of patients.

Wheeler, J. R. (1955). *Proc. R. Soc. Med*, 48, 1039

BREAST—CARCINOMA OF

See also B.S.P., Vol. 2, p. 456, S. Key 77.

Methods of spread

Cell migration, vascular dissemination and transplantation at operation

PRICE (1955) reviews the spread of mammary cancer. Cancer probably begins in some minute localized spot, a nest of cells, a single cell or, possibly, multicentrically. Generation occupies only a few hours, until millions of cells form a solid mass This tumour grows rapidly along the lines of least resistance, the "open trail" being the lymphatics. Tumour cells migrate, breed, excrete, and reproduce They work their way through delicate endothelium or capillary walls, in the lumen of which they are swept along by blood or lymph to reach a permanent lodging. The main lymphatic trunks provide roots to the axilla, mediastinum and abdomen. Reaching the nodes by afferent vessels, they invade or destroy them, emerging by efferent channels to seek new fields of conquest. Another method of spread is by the blood stream. Boyd (1953) stated that tumour emboli are not metastases, but experience shows that they can, and do, become malignant. Cancer cells, unfortunately, are also accidentally transplanted at operation Only the surgeon can see the gross spread of the disease; its utmost limits lie even beyond the vision of the pathologist. Early diagnosis and complete excision may effect cure, but in advanced cases even radical operation is unavailing. That classical mastectomy offers only 70 per cent 5-year "cure" in carcinoma limited to the mammary gland and only 30 per cent when axillary metastases are demonstrable, that more radical give better results than less radical operations; that patients without axillary metastases have a better prognosis than those with them; that results are improved by meticulous dissection, is all understandable when the impalpable spread of the disease is realized. "Ultra-radical" surgery and radiation have their limitations and Haagensen's and Stout's criteria of inoperability take on fresh significance.

Price, P. B (1955). *J. Amer. med Ass*, 159, 1345.

BRONCHIECTASIS

See also B.S.P., Vol 2, p. 501, S Key 81

Treatment

Resection

Results of operation.—CHESTERMAN (1955) records the results of resection for bronchiectasis in a consecutive series comprising 245 cases and 273 resections. The incidence of

collapse was only 40 per cent, not an aetiological feature in the majority of cases. Lobectomy and segmental resection in suitably selected unilateral cases gave a satisfactory result in 85 per cent, and there should be no operative mortality in this group. Pneumonectomy is associated with definite mortality and morbidity, but the satisfactory result was 75 per cent. Several pneumonectomy cases have had children without difficulty during pregnancy and parturition About half the lobectomy cases suffer from "chestiness" in the last 3 months but improve on delivery. As regards subsequent respiratory infections there is an impression

is unlikely, provided two major functioning lobes are left intact, or unless the patient indulges in strenuous exercise.

Chesterman, J. T. (1955) *Brit J. Tuberc.*, 49, 280.

BURNS AND SCALDS

See also B S P., Vol. 2, p 519, S. Key 82.

Burns

Amino-acid loss in urine

amino acid and the "total" amino acid were measured, and the amount of each amino acid in the "bound" form was determined by the difference between the two values. The results showed that the amounts of free and bound forms of the amino acids are greater in the period immediately after the burn than in the later period of convalescence. considerable

acids, and none were absent when the hydrolysed urines were tested. The results tend to indicate that the severity of the burn is closely related to the degree of the amino-acid loss in the urine.

Eades, C H , Jnr , Pollack, R L., and Hardy, J D (1955). *J. clin. Invest.*, 34, 1756

COLITIS

See also B S P., Vol. 3, p. 88, S Key 97.

Ulcerative colitis

Results of biopsy of the rectum

above the anal sphincter. An anaesthetic was only once needed in the removal of 180 specimens from 150 patients These persons were in various phases of ulcerative colitis and as a control, specimens were removed from normal bowel in patients being treated for

occasional argentaffin cell occurs.

a reticular basement membrane a

desquamates the surviving cells s

first cuboidal and then flattened and the many basophil dividing cells in the lower parts of

the crypts of Lieberkühn evidently replace the superficial cells. In the repair of the surgical trauma inflicted in their experiments the writers found that adjacent folds of mucosa tended to fall over the bare area covered by granulation tissue and soon after flattened cells grow out from adjacent crypts In the absence of secondary infection [illegible] diameter was covered in 11 da[illegible] ones In ulcerative colitis the [illegible] the sections removed 119 showed signs of activity and 48 were quiescent. The early active lesion seems to develop in the bases of the crypts where the basal cells stain [illegible]

[illegible]

Surgical treatment

Operat[illegible] of ulcera[illegible] 24 adult[illegible] this disease were caecostomy, appendicostomy and colostomy, but these methods were not uniformly successful. In 1913 Brown proposed an[illegible] of the faecal stream. [illegible] averaging about 20 per [illegible] and rectum had to be [illegible]

[illegible]

functions. In the remaining 8 patients, ileostomy combined with total colectomy plus [illegible]

[illegible]

surviving patients have been rehabilitated, the exception being the patient most recently operated upon who is still convalescing. Revision of the ileostomy has been necessary in 8 patients because of ileostomy dysfunction and 2 others have developed annoying prolapses.

Nickel, W. F., Jnr (1955) *Surg. Gynec. Obstet.*, **101**, 353.

Segmental colitis

Signs and symptoms, treatment

MANNING, [illegible]

[illegible]

intestinal haemorrhage occurred in 50 per cent; obstructive symptoms, similar to those of [illegible] carcinoma, [illegible] 1 month [illegible] given to 6 patients, produced only temporary improvement. Operations included 23 ileocolostomies, with resection of the diseased bowel, 10 without resection and 1 segmental resection of the descending colon with colocolostomy. After an average of 4 6 years, 19 patients were

The overall rate of arrest ent ileostomy was success-

Manning, J. H., Warren, R, and Adi, A. S. (1955). *New Engl. J. Med.*, 252, 850.

COLON—CARCINOMA OF

ee also B.S P., Vol 3, p. 103, S. Key 98.

olyps of the colon

ncidence and treatment

Series of cases reviewed—The majority of cancers of the colon, if not all, arise from

One patient died of carcinomatosis three years after operation, but none of the remainder as shown any signs of a recurrence

Smith, D. W. (1955) *Amer. J. Surg.*, 90, 870

COLON—DEVELOPMENTAL ABNORMALITIES AND MEGACOLON

See also B S P, Vol. 3, p. 130, S Key 991.

Megacolon and associated bladder dysfunction

Elimination as a post-operative complication

The relation of megacolon and megalo-ureter is discussed by Swenson and Fisher (1955). A study of patients before and after operation for Hirschsprung's disease revealed that some had defects of bladder function To eliminate this as a post-operative complication, studies

bladder dysfunction and dilatation of the upper urinary tract, investigation of these cases excluded obstruction at the bladder neck or uretero-vesical junction. An analysis of 60 cases of megalo-ureter showed that the cause was a parasympathetic bladder in 30, defect in ureteral peristalsis in 15, cord bladder in 7, and mechanical obstruction in 8 (ureterocele 4, posterior urethral valves 3, anomaly of perineum 1) those with congenitally aperistaltic ureters were found difficult to manage, as the disease is progressive with gradual destruction of all renal tissue Treatment consists of bladder-neck resection, with control of urinary tract infection, patients are taught to empty the bladder completely As the autonomic nerves enter the bladder at the uretero-vesical junction, dissection in this area should be avoided.

Swenson, O, and Fisher, J H. (1955) *New Engl J. Med*, 253, 1147.

Radiological investigation

grams and cystograms failed to disclose any abnormal action of the bladder In another

revealed on pyelography and an atonic bladder without ureteral reflux was demonstrated by

if the amount of residual urine is large or if the upper part of the urinary tract is dilated. Resection of the neck of the bladder reduces the outlet resistance. Sometimes prolonged antibiotic therapy is of value, but sympathectomy yields disappointing results. Direct drainage of the kidney is indicated if dilatation of the renal pelvis is progressive.

Allen, R. P. (1955) *Radiology*, 65, 325.

ELEPHANTIASIS

See also B.S.P., Vol. 3, p. 362, S. Key 125.

Post-operative lymph fistula

Three case reports

PARKS (1955) describes three cases of lymph fistula in the lower limb, complicating operations or incised wounds. The term "fistula", though not accurate, is used because of its descriptive aptness. The clinical course was similar in each patient. Following a clean

The flow of

was a clean

ococci, but the wound showed no signs of inflammation. Operative intervention in this patient allowed the organisms to spread and cause acute cellulitis. Infection in the wound was rapidly followed by closure of the fistula. Treatment in lymph fistula should be conservative in the first place, directed towards decreasing the lymphatic return from the limb,

ENDOMETRIOSIS

See also B.S.P., Vol. 3, p. 387, S. Key 130.

Pathogenesis

Implantation—induction theory

As the embryonic and Sampson's implantation theories on the pathogenesis of endometriosis do not provide a fully adequate explanation for all forms of endometriosis, Levander put forward an induction theory. According to this, specific substances may be liberated from the endometrium in the uterus and transported by the lymph and blood streams, subsequently inactivating an omnipotent blastema, newly formed in the organism, into

of a critical examination

igned to show whether

ation than endometrium

from rabbits in the last

thers immediately after

bits after treatment in a

itation preparation was

e centre of a space filled

oth the implant and the

arying thickness in the

eneration was usually

esent on the first day

g immature fibroblasts

ule, but there was no

ogressive degeneration

necrotic. In the inner-

psule In the treated implants, no endometrial cells were seen on the first day after nplantation, but a marked cellular reaction was present in the lymph space and capsular embrane There was no contact between the implant and this cellular reaction. By the ird day, a rich vascularization had begun in the capsular blastema, but no vessels were ident in the lymph space or implant. By the fourth day signs of an atypical epithelium were oserved on the implant, whilst in the capsular blastema a few small cysts were forming, nd by the seventh day, large numbers of cysts in different stages of development were

ndometriosis

Levander, G , and Normann, P. (1955). *Acta obstet. gynec. scand*, 34, 366.

ENDOSCOPY—BRONCHOSCOPY

ee also B S.P., Vol. 3, p. 392, S. Key 131.

oreign bodies in bronchi

ncidence and treatment

vhen asphyxia or fatality is imminent. Successful extraction and complete recovery are ossible in most cases; many of the complications and sequelae are the result of late diagnosis Post-operative radiography should be performed in all cases.

Maloney, W H (1955) *Amer. J. Surg*, 90, 453.

EYE—THERAPEUTICS OF

See also B.S P, Vol. 3, p 493, S. Key 143.

Treatment of eye emergencies

STALLARD (1955) describes the emergency treatment of certain eye conditions Free

and a pad and bandage are applied In cases of acute congestive glaucoma eserine sulphate, 1 per cent, is instilled repeatedly until the intra-ocular pressure reaches physiological limits. Pain is relieved by applying heat and injecting morphine A patient with occlusion of the central retinal artery requires inhalation of amyl nitrite and a retro-ocular injection of acetylcholine, but for thrombosis of the central retinal vein no immediate treatment is likely to be of any value For total retinal detachment atropine drops are instilled and both

eyes are occluded. If the detachment originates in the upper half of the fundus the patient should be sent to hospital in a recumbent position and if the detachment is in the lower half of the fundus the patient should be allowed to sit up.

Stallard, H. B. (1955). *Brit. med. J.*, 2, 1441.

FISTULA IN ANO

See also B.S.P., Vol. 4, p. 102, S. Key 154.

Ano-rectal fistula

Aetiology and surgical treatment

BUNNEY (1955) discusses the aetiology and surgical treatment of ano-rectal fistula. These fistulae begin as an infection of an anal gland at or near the posterior midline, the duct of which perforates the circular and longitudinal muscles. The infection extends superiorly between the longitudinal muscle and the external sphincter to form an abscess above the *ano-rectal line in the supralevator space, after which it perforates the rectum. It seldom if* ever penetrates into the pelvi-rectal or retro-rectal spaces Operation is best begun by inserting a probe through the external opening in the skin and laying the tract open in stages until the midline is reached. All sphincter muscle overlying the extensions of the tract into the anal canal is then incised, but the fibrous base of the fistula is left intact. The fistulous opening into the rectum must be replaced by healthy mucosa and the ano-rectal ring left intact. This can be accomplished by using *the technique described by Gant in the treatment* of rectovaginal fistula If correctly planned, this operation results in little deformity or loss of control

Bunney, G (1955). *Amer. J. Surg*, 90, 863.

FRACTURES, DISLOCATIONS, FRACTURE-DISLOCATIONS AND ALLIED INJURIES

See also B.S.P., Vol 4, p 165, S. Key 157.

Patella

Recurrent dislocation

Operative cure.—HARRISON (1955) presents *the long-term results of an operation for the* cure of recurrent dislocation of the patella. The lateral patellar retinaculum and vastus [illegible]

Four of the cases were under the age of 13 years, and developed genu recurvatum. [illegible] ... may be better to re-implant the tubercle less [illegible] the many different methods [illegible] results with those of others, but feels that the over-all results obtained by the technique [illegible] very favourable.

Harrison, M. M. (1955) *J. Bone Jt Surg.*, 37B, 559.

Fractured calcaneus

Treatment

Necessity for functional restoration.—There have been a great number of methods proposed for the anatomical restoration of a fractured calcaneus, so many that the necessity for functional restoration has perhaps been obscured. BARNARD and ODEGARD (1955) have considered the soft tissue injuries accompanying this injury, and have evolved a therapeutic [illegible] function, with its [illegible] foot in maximum [illegible] under the heel is [illegible] the period of [illegible] foot are avoided. [illegible]

from narrowing of the osseo-ligamentous tunnel for the peronei The authors have treated 22 fractures in this manner, the average period of disability in 19 of these being 13·7 weeks. The period for the others was prolonged by associated injuries. The authors consider that these results are encouraging, and that such a regime will greatly reduce the number of cases requiring subtalar arthrodesis.

Barnard, L, and Odegard, J. K. (1955). *J. Bone Jt. Surg.*, 37A, 1231.

Ankle

Acute inversion sprains

Follow-up of cases.—Acute inversion sprains of the ankle with tearing of the lateral ligament are usually treated in a manner which ensures the most rapid return to work. Prolonged follow-up of such cases is uncommon, unless there is some marked residual

symptoms following acute ankle sprains.

Bosien, W R., Staples, O S, and Russell, S. W. (1955). *J. Bone Jt. Surg.*, 37A, 1237.

Hip

Recurrent dislocation

Case history—Frequently recurring dislocation of the hip is rarely seen, and has only been recorded in 7 cases. SULLIVAN, BICKEL and LIPSCOMB (1955) report a case of a male aged 60 years who had a right amputation of the leg for carcinoma of the foot. Three years later he sustained posterior dislocation of the left hip from a fall, which was reduced, the patient making a good recovery. In the next 3 years the hip dislocated 3 times, and 4 years later it dislocated 3 times in 1 year Accordingly, the joint was explored, the gluteus minimus was torn longitudinally over the posterior aspect of the capsule, there being a corresponding rent in the capsule itself. A buttress of iliac bone was screwed on to the upper posterior margin of the acetabulum, the tears in muscle and capsule repaired, and the wound closed. Post-operatively, good progress was made and almost normal hip function obtained.

Sullivan, C R., Bickel, W H, and Lipscomb, P R (1955). *J. Bone Jt. Surg.*, 37A, 1266.

Shoulder

Recurrent dislocation

bony
delto-
capsul
humer

intact it is stapled on to the
the c
insert
inch
Move
series
move
stapling ... efficient substitute for drilling and suturing.

Du Toit, G. T., and Roux, D. (1956). *J. Bone Jt. Surg.*, 38A, 1.

Femoral neck

Non-union after displaced intracapsular fractures

There have been many suggested explanations of the frequent occurrence of non-union after displaced intracap...

... blood supply to the head is poor. When a straight nail is employed for internal fixation, the degree of immobilization depends on the integrity of the bone structure of the upper end of the femoral shaft. The nail is usually firmly grasped by the dense trabeculae of the femoral head, but the trabeculae at the upper end of the shaft are more loosely arranged, and in some parts of the neck are absent. The distal fragment in such cases is held only by the cortex, which in the aged may be extremely thin, so that considerable movement in the vertical plane ...

... cases required re-nailing several weeks after the primary operation as the original nail became disengaged from the head; successful union followed. These were the only 2 cases to whom a plaster cast was applied. In 5 cases the nail protruded through the femoral head, but the protrusion was sufficient to warrant removal of the nail in only 3 of these. Some degree of aseptic necrosis occurred in 4 patients. Although the series is small, the use of a combined nail and plate has been shown to be a safe procedure, and, by virtue of the improved immobilization accompanying its use, appears to increase the likelihood of bony union.

Eaton, G. O. (1956). *J Bone Jt. Surg.*, 38A, 23.

Displacement osteotomy

In a 20-year period, WARDLE (1955) has performed displacement osteotomy of the upper end of the femur on 69 patients suffering from ununited fractures of the femoral neck, or unreduced congenital dislocation or osteoarthritis of the hip joint. After oblique subtrochanteric osteotomy, the lower fragment was immobilized at such an angle of abduction that, when united and the leg adducted into a weight-bearing upright position, the upper fragment would be in the position of maximum adduction Only if this position is obtained can the best result be expected Where the correct angle has been achieved in the author's series, the joint space in some cases has reappeared, and ununited neck fractures have healed Forty of the cases have been ... years. Thirty-one were enthusiastic abo... sidered that the operation had not been
and ... as poor ...
cannot tolerate
which has allowed the patient to be nursed in bed without a plaster cast. The author concludes that this type of operation should continue to be given serious consideration.

Wardle, E N. (1955). *J. Bone Jt. Surg.*, 37B, 568.

GALL-BLADDER AND BILE PASSAGES

See also B.S.P., Vol. 4, p. 238, S. Key 161.

Methods of examination

Intravenous cholecystangiography

Study of 100 *cases.*—A study of 100 cases in which the biliary tract was examined by intravenous cholecystangiography is presented by BATT (1955). The new method, in which a chemical compound named Cholografin is used, has made it possible to demonstrate the bile-ducts radiologically even although the gall-bladder is absent or abnormal. Its greatest advantage is in studying the patient who has had cholecystectomy, but it has also been valuable in cases of gall-bladder disease in which the ordinary Graham test has been

griping, dysuria, and urticaria.

Batt, R. C. (1955). *Radiology*, 65, 926.

Intravenous cholecysto-cholangiography

In
bil
vis
from gastro-intestinal dysfunction or to gall-bladder disease. In known cases of allergy or with strong positive tests prior to administration, premedication with Benadryl is recommended. Warmed to body temperature, 40 millilitres of Cholografin is injected slowly for 10 minutes

bladder is seen in from 10 minutes to 2½ hours after injection and, once filled, its examination is completed as after oral cholecystography. In the presence of obstructive jaundice, the ducts cannot be visualized. Normal hepatic and common bile-ducts measure 0 5–0 6 centimetre in diameter, the cystic duct 0 2–0 3 centimetre. Any departure from these measurements is abnormal and may reveal duct calculus, stricture, stenosis of the sphincter of Oddi, intrinsic tumour or extrinsic pressure. Results suggest that compensatory dilatation of the main ducts does not follow cholecystectomy but, in the absence of calculi, adhesions or tumours, is usually caused by stricture of the duct or stenosis of the sphincter of Oddi. The so-called post-cholecystectomy syndrome then is probably a late recognition of conditions existing before operation, whether or not the gall-bladder was diseased at this time. Cholangiography has shown the most frequent cause of dilatation of the extrahepatic duct to be stenosis of the sphincter of Oddi. It has also revealed important anatomic variations, residual cystic duct stumps and "reformed" gall-bladders.

Shehadi, W. H. (1955). *J. Amer. med. Ass.*, 159, 1350.

Biliary tract and pancreatic surgery

Hallenbeck and his associates (1955) present a report on biliary tract and pancreatic surgery for 1954. Among 65 patients with acute cholecystitis, cholecystectomy revealed gall-bladder calculi in 59; 7 patients also underwent exploratory choledocostomy and stones were recovered from the common ducts of 6. Cholecystostomy was done in the remaining 6 cases. Of 1,036 patients operated on for chronic cholecystitis, 93 per cent had gallstones. Cholecystectomy alone was done in 769 cases, in 246 it was combined with common duct

the common or hepatic ducts, various anastomoses were performed. Section of the sphincter of Oddi was done in 35 cases, 21 being pancreatitis. Seven pancreatic pseudocysts were treated. Carcinoma of the pancreas occurred in 76 cases, in 34, only exploration was possible. The Whipple operation was successfully performed in 7. The mortality rate of 1 4 per cent resulted chiefly from cardiac, vascular and renal complications.

Hallenbeck, G. A., Walters, W., Gray, H. K., Priestley, J. T., and Waugh, J. M. (1955). *Proc. Mayo Clin.*, 30, 640.

Biliary-tract disease

Diagnosis and treatment

Zollinger, Boles and Crawford (1955) review the diagnosis and treatment of biliary-tract disease. Complications include common-duct calculi, acute cholecystitis and pancreatitis. Cholecystography is highly accurate, but a single examination with non-visualization is inadequate. The positive demonstration of stones indicates operation, but poor filling,

delayed emptying and unusual size or shape of the gall-bladder do not warrant surgery. Heart disease does not alter surgical indications in recurrent gall-stone colic or acute cholecystitis, in fact, "cardiac patients" are often completely relieved after operation. "Silent" gall-stones
or recurren
50 years of
occurs, surg
early exace
perforation ... In this series of cases the gall-bladder was evacuated, the impacted calculus dislodged and the gall-bladder removed from the fungus downwards. In 14 per cent of 37 acute cases, calculi were recovered from the common duct. Cholecystostomy was performed in 8·6 per cent cases where gall-bladder abscess occurred or technical difficulties were encountered. Common-duct stone, present in approximately 20 per cent cases of cholelithiasis, may be asymptomatic, produce jaundice, or obstruct the pancreatic duct; if it escapes detection at operation, recurrent symptoms result. After the age of 60, twice as many calculi are recovered. Indications for exploration of the common duct, without which cholecystectomy should not be undertaken, are enlargement, small gall-bladder stones, history of pancreatitis and sec...
complicates the diagnosis between hepatitis and cor...
and liver tests are essential and surgery should ...
evaluated. The technique of cholecystectomy is described.

Zollinger, R. M., Boles, E. T., and Crawford, G. B. (1955). *New Engl. J. Med.*, 252, 203.

Cholecystic and coronary disease

Review of 100 patients

...

in 6 six cases the gall-bladder was acutely inflamed. Operative precautions included high-percentage oxygen anaesthesia and preparation for cardiac emergencies. In 7 per cent of the patients, post-operative thrombophlebitis developed. Of 3 men, whose case histories are reported, 2 died from pancreatitis, the third from contributory coronary insufficiency. The 6-year survival rate in this series was 70·6 per cent, compared with 83·9 per cent in the equivalent normal population, in 36 per cent the cardiac condition was unchanged, 17 were improved, 11 had retrogressed. Cholecystectomy, therefore, cannot be considered a cure for coronary disease.

Keys, J. R., Dry, T. J., Walters, W., and Gage, R. P. (1955). *Proc. Mayo Clin.*, 30, 587.

Cholangitis

Choleduodenostomy

STOCK and TINCKLER (1955) discuss choledocho-duodenostomy in the treatment of cholangio-hepatitis. Among the indigenous population of Hong Kong, cholangio-hepatitis

...

inspissated biliary debris which may consolidate into friable, multifaceted calculi. In cholangio-hepatitis, in contrast to cholecysto-lithiasis, the ducts themselves are the site of

...

spasmolytics and sedation they can not be distinguished pre-operatively, as the calculi in cholangio-hepatitis are usually non-radio-opaque; it is preferable, therefore, to regard all

the cases as having calculus obstruction. In the authors' technique, the distal end of the

Stock, F. E., and Tinckler, L. F. (1955). *Surg. Gynec. Obstet.*, **101**, 599.

Cholelithiasis

Cholecystectomy

Persistence or recurrence of symptoms—In 10–15 per cent of patients with cholelithiasis treated by cholecystectomy, symptoms persist or recur. Although these usually appear to be due to some condition other than cholelithiasis which was not recognized or properly evaluated prior to cholecystectomy, quite often they are due to an incomplete operation in which stones or a remnant of the gall-bladder or cystic duct has been left behind. GLENN and JOHNSON (1955) review 35 cases of cystic duct remnant seen during a 22-year period at the New York Hospital—Cornell Medical Centre. An additional 148 cases from the literature are also reviewed. The average age of the patients was 52 years and females outnumbered males by 3 4 to 1 The symptoms of the cystic-duct remnant were identical with those of gall-bladder disease, but pain was more severe and jaundice occurred in 19 although a common-duct stone could not be demonstrated in 7 of these. Rigors and fever occurred in 20 per cent and 3 patients had a biliary fistula. There was a lag interval between the cholecystectomy and the recurrence of symptoms averaging 3 8 years. One patient was asympto-

common duct were found in several. Stones were found in the cystic-duct remnant in 10 cases and common-duct stones in half of the 26 choledochotomies performed. A gall-bladder remnant was found in 9 cases, 3 of which contained stones. Changes of acute or chronic inflammation were present in all but 3 of the 24 cystic-duct remnants examined Perforation of the remnant had occurred in one case There were 3 deaths in this series. Of the 27 cases adequately followed up, 19 consider themselves well, 5 still have minor complaints, whilst 3 have had to undergo further surgery, stones being found in the common duct in 2 and a persistent cystic-duct remnant in the other An appreciation of the anatomical variations of the cystic duct in relation to the common duct and greater attention to technique by the surgeon should decrease the incidence of cystic-duct remnants

Glenn, F , and Johnson, G , Jnr. (1955) *Surg Gynec Obstet.*, **101**, 331

Neoplasms of gall-bladder and bile-ducts

Study of 113 *cases*

Extra-hepatic biliary-duct cancer is discussed by GLENN and HILL (1955) A study has

artery, the common duct, and the associated portal vein down to the duodenum. In carcinoma of the extra-hepatic bile-ducts, radical procedures are less applicable than in other groups, palliative procedures, including local resection for distal common-duct lesions, have been the most satisfactory Since the introduction of radical

the diagnostic and surgical approaches available at present; extension of survival and palliation have been the experience of the authors in these cases, radical surgery aimed at cure should be used further, although the operative mortality has been high.

Glenn, F., and Hill, M R., Jnr. (1955) *Cancer, N.Y.*, **8**, 1218.

GASTRO-COLIC FISTULA

See also B.S.P., Vol. 4, p. 272, S. Key 164.

Gastrojejunocolic fistula

Clinical picture and treatment

Gastrojejunocolic fistula is discussed by RHIND (1955) who describes 5 cases which differed very much from the usual picture of this condition. The first had had posterior gastroenterostomy for duodenal ulcer in 1938 and had not been comfortable thereafter, being seen again in hospital in 1952. He had had pain and vomiting at about 3-month intervals and been away from work several months each year. Bowel action was normal and weight maintained. A barium enema showed a gastrojejunocolic fistula and at operation the anastomosis and fistula were separated and the parts repaired before a high partial gastrectomy was done. Recovery was uneventful. Another patient had been treated for duodenal ulcer by partial gastrectomy and retrocolic anastomosis but a month later developed a gastrojejunal ulcer which responded to medical care. A year later pain recurred with diarrhoea and foul eructations but no vomiting. Medical measures again gave some relief but a barium meal showed a large ulcer in the jejunum near the stoma. A year later he perforated near the anastomosis and at operation the colon was separated with difficulty and the holes were closed He was well 2 years later. Before the last intervention he had had a transthoracic vagotomy which was followed by a tendency to diarrhoea. The other of the 5 cases were of similar nature. The writer notes that in addition to these he has performed gastrectomy for 23 other cases with anastomotic ulcer so that fistulae occurred in about 15 per cent of his total. Some suggest that intermittent symptoms in fistula are rare but in the last of his 5 cases the writer recorded long intermissions of pain and he pleads that mild cases should be suspected and thus recognized in the absence of the supposedly severe and persisting symptoms

Rhind, J. A (1955). *Lancet*, 2, 1225.

GENITAL ORGANS—FEMALE EXTERNAL

See also B.S.P., Vol. 4, p. 289, S. Key 166.

Vulva

Carcinoma

[illegible] carcinoma of the vulva is discussed by EASTON and [illegible] records at the Middlesex Hospital, London, [illegible] 4 per cent of the number of cases of genital tract cancer. The average age for patients suffering from the condition was 62 years Unexpectedly good results were obtained with simple vulvectomy, but many cases were of relatively low malignancy. When the lymphatic glands were affected by the disease the prognosis was extremely grave. Most patients who died within 5 years showed invasion of [illegible]

glands a[illegible]
glands ar[illegible]
gland tis[illegible]
divided. [illegible]
in the superficial glands, for these glands are numerous and widely [illegible] devise flaps from the [illegible] o close the wound [illegible]

Easton, A. L. T., Andrews, P. S., Way, S., and Charles, A. ([illegible]). *Proc. R. Soc. Med*, 48, 1091.

GUNSHOT WOUNDS AND ALLIED INJURIES (GENERAL MANAGEMENT)

See also B.S.P., Vol. 4, p. 352, S. Key 174.

Thorax and abdomen

Pre-operative and operative treatment

GRATTAN (1955) discusses the management of gunshot and sword wounds of the thorax and abdomen. The discussion has special reference to the treatment of 46 Africans;

there were 10 fatalities in this series of cases Conservative treatment is indicated in the management of haemothorax due to through-and-through gunshot wounds Aspiration of the chest does not increase the risk of precipitating further haemorrhage. Infection is combated with penicillin injections, and streptokinase-streptodornase is injected in cases of clotted haemothorax Thoracotomy should be employed if 2–3 pints of blood are withdrawn

out local excision. As for penetrating wounds of the abdomen, haemostasis is a primary requirement Auto-transfusion is a useful measure even when the blood is found to be grossly contaminated Exteriorization of the injured colon is required only when the degree of bruising or viability is in doubt and when resection is precluded owing to the patient's condition In a patient with thoraco-abdominal injuries the abdominal injury should be given priority so far as surgical intervention is concerned.

Grattan, E (1955). *Brit. J. Surg.*, 43, 279

HAND

See also B S P., Vol 4, p 386, S Key 178

Major infections of the hand

Diagnosis and treatment

FLYNN (1955) reviews major hand infections, namely lymphangitis, deep-fascial-space abscess, and acute suppurative tenosynovitis Diagnosis and treatment depend upon knowledge of the
an abrasion or w
Red streaks exten
history of deep in
of the entire hand and forearm In both, there is voluntary and painless movement of the fingers, no pain on hyperextension, no tenderness over the tendon sheaths, no palmar bulging and no tenderness over the mid-palmar and thenar spaces Its incidence is 15–25 per cent less than before antibiotic therapy Treatment includes warm sterile saline dressings, immobilization, fluids and penicillin, 100,000 units, 4-hourly Complications, although greatly diminished since the advent of antibiotics, include sloughing of connective tissue, nodal abscesses, subpectoral abscess and pus under the pectoral and subscapular muscles. These must be incised and drained The humoral chain of axillary nodes emptying into the

injection of pen
sutt
imm
clin

Flynn, J E (1955). *New Engl. J Med.*, 252, 605.

Dupuytren's contracture

Incidence, aetiology and predisposing causes

Survey of 5,000 patients—YOST, WINTERS and FETT (1955) describe a survey in which more than 5,000 patients were examined for evidence of Dupuytren's contracture The deformity was observed in 120 males and 51 females, and the average age of these patients was 68 years As compared with the findings in previous surveys the condition was found in a relatively large number of women Few Negroes showed signs of the deformity. One man stated that his father had also suffered from it The left and r

in approximately equal numbers, and contraction of the ring finger
Trauma was not co
specific injury associ
that a predisposition
large-handled t ... ller hand tools. No
correlation was ... seases. Pain was not
a common comp... ew patients complained of the contracture and no patient wished to have it corrected by means of surgical treatment.

Yost, J., Winters, T., and Fett, H. C., Snr. (1955). *Amer. J. Surg.*, 90, 568.

HERNIA

See also B.S.P., Vol. 4, p. 428, S. Key 180.

Inguinal herniorrhaphy

Criticism of procedures

Inguinal herniorrhaphy is described by Doran (1955) who remarks that the usual procedures are being more severely criticized every day. Success depends as a rule on establishing adequate union between the conjoint tendon and Poupart's or Cooper's ligament. But any tissues sewn together under tension easily separate and even 50 years ago some of the current methods were suspect. By inserting radio-opaque markers into the tissues to be joined together it has been possible to demonstrate their separation within a few months. The

and the anterior superior spine. Arising from this ...
of the internal oblique apone
in maintaining the integrity
arise from the outer part of
aponeurotic sheet which for
in such a way as to overcome the passive resistance to joining the internal obli...
or the conjo
protects the
arising from
without this
the absence
these muscle
this which e

operation.

Doran, F. S. A. (1955). *Lancet*, 2, 1307.

Problems in the treatment

... nt of hernia. The trans-
... which at the deep inguinal
... n, filmy layer; frequently
... by the inferior epigastric
vessels, a true fascial margin is absent. The conjoined muscles help to maintain the integrity of the canal, if we believe that this control can be regained, the muscles may be left as functioning units, otherwise there is inevitably some fibrous tissue replacement of their

always be considered as the most effective safeguard against recurrence. In the repair of

the skin is
is; any

Farquharson, E L. (1955) *Ann R. Coll. Surg. Engl*, **17**, 386

Retromesocolic hernia

Case report

SMITH (1955) describes a case in which a retromesocolic hernia developed to the right of the middle colic artery. *The hernia occurred in a girl, aged 5 years,* with generalized

exception, because the retromesocolic hernia usually lies to the left of the middle colic artery.

Smith, C. C K (1955). *Brit med J.*, **2**, 1487.

INFECTION, INFECTIONS AND INFLAMMATION

See also B.S P., Vol. **5**, p 86, S. Key 192

Cortisone

Use in suppressing inflammatory reactions

Mechanism of suppression—Cortisone in sufficiently large doses is known to suppress inflammatory reactions, but the mechanism of suppression is not understood. ALLISON, SMITH and WOOD (1955) have studied the effect of cortisone on standard inflammatory lesions produced by thermal injury to the rabbit ear. They found that the period of initial peripheral ischaemia was prolonged, and that as the circulation was restored, there was a long delay before the appearance of vasodilatation The degree of dilatation was very small even after a considerable period Permanent occlusion of the vessels in the injured area occurred as in untreated animals Refractile globular bodies can be seen in lesions produced in rabbits not given cortisone, and their production was unaffected by the drug. Rouleaux formation occurred early, being rapidly followed by the normal vascular stasis Oedema formation and haemorrhage were much less than in untreated animals Appreciable leucocyte sticking was usually delayed for up to 3 hours, and did not reach the intensity or extent that can be seen in untreated specimens. Within 6 to 9 hours after injury the sticking began to regress, and after 24 hours was only occurring at isolated spots on the periphery of the

which initiate inflammation

Allison, F, Smith, M. R., and Wood, W. B. (1955). *J. exp. Med*, **102**, 669.

INTESTINES

See also B S.P, Vol **5**, p. 121, S Key 195.

Benign tumours of the small intestine

Series of 22 cases

SHANDALOW (1955) discusses benign tumours of the small intestine, relatively infrequent usually asymptomatic and often incidental In this series of 22, encountered in 2,648

result in necrosis and malignant degeneration. Lipoma is a rare, yellowish, soft, sessile, non-invasive mass sometimes causing intussusception. True fibroma is rare; when extra-luminal, it may be the size of an adult head. Neurofibroma probably originates along the autonomic fibres. Single or multiple, sessile or pedunculated, large or small, it occasionally causes

is freq

matic,

a large

skin naevus or to melanoma of the retina or rectum; it may, however, be primary and melanoblastic in origin. The complications of haemorrhage, obstruction, intussusception, ulceration and malignant degeneration should first be distinguished, by barium x-ray or

causes. Treatment is simple excision,

gery. Uncomplicated cases, however,

Shandalow, S. L. (1955). *Arch. Surg. Chicago*, **71**, 761.

Malignant argentaffinoma of the small intestine

Two case reports

JENKINS and BUTCHER (1955) discuss two cases of malignant argentaffinoma, the association of which with cyanosis and pulmonary stenosis was already known. The first patient seen, a woman of 63, had complained for 18 months of intermittent lassitude with watery diarrhoea,

of the caecum and metastases were seen in adjacent lymph nodes and in the liver identified as those of an argentaffinoma. In the second case complaint of dyspnoea and intermittent diarrhoea for 2 years was made by a woman of 59. Four months before admission she had

failure was made and treatment was designed

coma 8 weeks later. The autopsy findings we

pulmonary stenosis was evident, also tricuspid incompetence. The primary growth was in the ileum.

Jenkins, J. S., and Butcher, P. J. A. (1955). *Lancet*, **1**, 331.

Primary mesenteric venous thrombosis

Symptoms and treatment

laparotomy, a large quantity of serosanguinous fluid was found in the peritoneal

Mesenteric thrombosis involved the upper 2 feet of jejunum. Resection and end-to-end jejunostomy were performe

the lumen contained blood

case, also

died from

jejunem.

The pathology and microscopic appearances were identical in every case. In Cases 2 and 3 there was a history of thrombophlebitis of the legs, an implication regarded by North and Wollenman (1952) as important.

Bussey, C. D. (1955). *Arch. Surg., Chicago*, **71**, 658.

Congenital atresia below the duodenum

Operative mortality

Review of literature and 10 *cases.*—GERRISH (1955) has reviewed the literature on congenital intestinal atresia below the duodenum, and presents the findings in 10 further cases. Increased awareness of the condition has led to a decrease in the immediate operative mortality, as the infants come to surgery in much better general condition. Later deaths have been due to the difficulty in such young patients of maintaining an adequate nutrition and electrolyte balance. Some have also died through breakdown of the intestinal anastomosis. To overcome these difficulties the author uses end-to-end anastomosis after resection

from a relieving operation Two other deaths occurred, 1 from failure to decompress the proximal loop, and 1 due to massive necrosis from a pre-operative volvulus. The author concludes that his method is easier to perform than exteriorization, does not require a secondary operation, and avoids the necessity for a long period of supportive therapy, with its attendant dangers of electrolyte imbalance in an infant.

Gerrish, E W (1955) *Ann Surg*, **142**, 469.

INTUSSUSCEPTION

See also B S.P , Vol. 5, p. 160, S Key 200.

Recurrent ileocolic intussusception

Associated with hypertrophy of Peyer's patches

Surgical treatment—SARASON and his associates (1955) describe a case of recurrent ileocolic intussusception associated with hypertrophy of Peyer's patches. The patient, a male infant, was first operated on for an ileocolic intussusception at the age of 4 months. No intrinsic abnormality of the terminal ileum was observed Surgical reduction of a

metres of the terminal ileum were definitely thickened and an ileocaecal resection was performed Gross examination of the resected specimen revealed 2 mucosal thickenings completely encircling the bowel lumen, 1 of which involved the ileal surface of the ileocaecal valve, whilst between the thickenings there were 4 shallow ulcers in the mucosa. The thicken-

Sarason, E L , Prior, J. T., and Prowda, R L (1955) *New Engl. J. Med*, **253**, 905.

JAUNDICE

See also B S P , Vol. 5, p 176, S Key 198.

Obstructive jaundice

Clinical diagnosis

BRUCE (1955) discusses the clinical diagnosis of obstructive jaundice. Although early differentiation into "surgical" and "medical" jaundice is often easy, many baffling cases

... jaundice is easily recognized: in atypical cases, a permanently ...

... of the gall-bladder, certain evidence of extrahepatic obstruction and almost certa... malignant

Bruce, J., C.B.E. (1955). *J.R. Coll. Surg., Edinb.*, I, 149.

Diagnostic procedures

GRAY and RINSLER (1955) discuss diagnostic procedures in obstructive jaundice. Fou... 5 simple tests are essential and usually sufficient to confirm the diagnosis, establish the ca... and indicate secondary liver damage. ...

... is not; it may, however, occur in jaundice ... ...d bile passages after bacterial infection. Ser... ...ce and its estimation is essential in suspec... haemoly... tase, elev... condition... than are... but comb...

Gray, C. H., and Rinsler, M. G. (1955). *J.R. Coll. Surg., Edinb.*, I, 159.

Decompression of hepatic duct system

STRAUSS and his colleagues (1955) discuss surgical decompression of the hepatic du... system in chronic jaundice resulting from acute and subacute hepatitis. The patholog... process in hepatitis involves the liver and entire ductal system; the ducts, in cases of lon... standing jaundice, become greatly dilated and exude quantities of bile and pus wh... opened. Clinically, 3 groups of patients are encountered; those with colicky attacks ...

... Histologically, the condition resembles acute yellow atrophy. The pancreas varies in co... sistency; peripancreatitis causes omental adhesions and even obliteration of the less... omental cavity. In 1 patient, a severe infiltrating duodenal ulcer near Vater's papilla cause... intermittent jaundice for 10 years. Severe liver damage and coma resulted, with duoden...

... recurs, the Roux Y operation is advocated. Details are given.

Strauss, A. A., Strauss, S. F., Schwartz, A. H., Tannenbaum, W. J., Kram, D. D., and Masur, W. W. (1955). *J. Amer. med. Ass.*, 159, 739.

JOINTS—TUBERCULOSIS

See also B S.P., Vol. 5, p 219, S. Key 207.

Treatment

Use of anti-tubercular drugs

Combination with arthrodesis—SMITH (1955) has considered the treatment of bone and joint tuberculosis with the aid of the new anti-tubercular drugs. Prior to the advent of surgical arthrodesis, results of joint tuberculosis were appalling, and in many cases misdiagnosis had occurred Operative interference increased the recovery rate, and also reduced

infection was walking without support 6 months from the commencement of treatment. Where, prior to antibiotic therapy, tuberculous abscesses were never opened, most will now resolve after removal of the primary focus, and can be drained if necessary. In a further 3 cases antibiotic therapy and plaster immobilization were used to treat joint tuberculosis after arthrotomy, without arthrodesis. Two of these achieved complete cure, and in 1, a hip infection, some coxa vara ensued but the infection was completely overcome The author concludes that the antibiotics are of great value, particularly in fulminating cases, abscesses, and sinuses, but that in most cases their use should be combined with arthrodesis In all cases, the diagnosis should be fully established, and the follow-up continued for a long time.

Smith, A DeF. (1955). *J Bone Jt. Surg.*, 37A, 1214

KIDNEY AND URETER—DENERVATION OF THE KIDNEY

See also B S P , Vol. 5, p 259, S Key 209

Nephroptosis

Nephropexy

ne
ni
pr
ago, nephropexy was used commonly on very slight indications and without previous urological study, and this has resulted in the operation being brought into disrepute so that many patients are now deprived of the surgical relief that could be afforded provided true indications for operation are present The commonest symptom of nephroptosis is pain after exertion or after standing for some time The pain may be severe or of a dragging or aching character, sometimes confined to the loin, sometimes with an anterior or distal radiation. Even when the kidney cannot be easily palpated, a slight degree of mobility in

for 10 days and then only gentle exercise for 2 months as too early exertion may precipitate

cases interrogated 6 months to 13 years after operation results were still good or moderately good in 28 and poor in only 3

Silverton, R. J (1955). *Med J Aust*, 2, 925.

KIDNEY AND URETER—TUBERCULOSIS

See also B.S.P., Vol. 5, p. 307, S. Key 213.

Treatment

Investigation of conservative methods

The treatment of renal tuberculosis is discussed by
of spontaneous recoveries from renal tuberculosis
given by streptomycin and various chemotherapeuti
possibilities of treating the disease conservatively.
kidneys), classified in 8 groups according to radiolo
showed that conservative treatment plus nephrectomy was much superior to conservative treatment alone, as regards relief of symptoms, destruction of bacilli, and fitness for work.
The study
excellent re
also valual
papillae, or ... the renal pelvis (groups 2–3 of the present series), recovery occurred in 29 of 31 cases; only 25 were free from tubercle bacilli, however, possibly because of activity of

... of a kidney with complete destruction, in the present series, give support for resection of a small focus, that is, a smaller but radical operation, although some normal renal tissue must be sacrificed; some cases suggest that prolonged conservative therapy may normalize parts of the kidney which, radiologically, seem to lack functional capacity.

Franzas, F. (1955). *Acta chir. scand.*, 110, 31.

Selective principle

Semb (1955) writes on the selective principle in the treatment of urogenital tuberculosis, partial resection of the kidney and of the ureter. Mass examination of the urine for tuberculosis has revealed that 3 to 4 per cent of patients with pulmonary tuberculosis in Norway have positive urine culture and 10 to 20 per cent of cases have bone and joint tuberculosis.

that renal tuberculosis

mass examination for tubercle bacilli in the urine analogous to the examinations of the sputum. In the selective medical-surgical treatment the medical treatment is principally directed against the non-destructive infiltrations of the urogenital tract. The surgical treatment aims at the removal of the active, necrotic, destructive foci of the ulcero-cavernous type, which represent the source of the disease, through selective operations with preservation of a maximum of healthy functioning tissue and not removing the non-destructive foci (infiltrations) which may heal spontaneously or by medical treatment. As regards medical treatment, sanatorium treatment combined with A+C treatment is advocated in all cases

has proved effective in renal tuberculosis as in pulmonary tuberculosis.

Semb, C. (1955) *Urol. int*, 1, 359.

Chemotherapy

(1955) have compared 90
ent, with 132 patients
early cases received
ls and 75 per cent of
everity appeared to
decrease conversion frequency, due to a possible decrease of renal function. The combination INH+DHS+PAS was superior to DHS+PAS. The chemotherapy cases were marked by

made for at least 3 years after completion of treatment

Halkier, E, Meyer, J., Palmlov, A, Jonsson, G., Mathisen, W., Hoeg, K., and Arnesen, A. (1955). *Acta chir. scand*, 110, 51.

Comparison of different preparations of PAS

and produced a high urinary concentration

Obrant, Ola (1955). *Acta tuberc scand.*, 31, 289.

LUNG—TUMOURS

See also B S P., Vol 5, p. 450, S. Key 225.

Cytology of sputum

Koss and Richardson (1955) summarize the main causes of potential diagnostic errors

in the presence of clusters of densely packed elongated cells with dark dense nuclei. Confusion between these clusters and clusters of cells of anaplastic carcinoma can be avoided if, besides all the cellular characteristics of malignant cells, consideration is given to the fact that

clusters of exfoliated cancer cells are usually arranged rather loosely, isolated single malignant cells are almost invariably present, and that the cells in the atypical bronchial clusters are

[illegible]

and if they do, it can be seen that they do not have the characteristics of malignant cells except for slight irregularities of the nucleus and cytoplasm. Numerous clusters of lymphocytes are present in the sputum of most cases of bronchogenic carcinoma and their presence in the absence of suspicious cells suggests that a repeat examination be performed. Macrophages, particles of acellular material, and vegetable cells may occasionally cause confusion with cancer cells.

Koss, L. G., and Richardson, H. L. (1955). *Cancer, N.Y.*, 8, 937.

Asymptomatic cancer

Surgical treatment

Potential curability.—OVERHOLT, BOUGAS and WOODS (1955) review the surgical treatment of lung cancer found on x-ray survey. Asymptomatic cancer has a higher rate of resectability and a greater potential curability than symptomatic; 46 such silent cases are presented. In 30 of these, a 3-year survival rate of 30 per cent compares favourably with 12 per cent for

[illegible]

shaped lesion is the common [illegible]
bronchus. Satellite nodules, [illegible]
or years, do not exclude canc[illegible]

[illegible] enlarged lymph nodes or by resection of the lesion. If malignancy is found, lobectomy or pneumonectomy is performed.

Overholt, R. H., Bougas, J. A., and Woods, F. M. (1955). *New Engl. J. Med.*, 252, 429.

Relation of occupation and smoking to lung cancer

Report of study

[illegible] study of occupation and smoking [illegible] ung cancer patients at the Roswell [illegible] r each age-residence category was [illegible] the control samples had an age- [illegible] oup. Out of 18 major occupation [illegible] metal products and

[illegible]

these occupations could not be explained by smoking. Individuals who had never [illegible] comprised 45·3 per

[illegible]

effect on those in occupations not associated with lung cancer. There was [illegible]

of an additive effect of smoking and occupation amongst cigarette smokers, but the factor of occupation did not account for the higher incidence of lung cancer amongst cigarette smokers.

Levin, M. L., Kraus, A. S, Goldberg, I. D., and Gerhardt, P. R. (1955). *Cancer, N.Y.*, 8, 932.

MOUTH AND PHARYNX, MALIGNANT DISEASE OF

See also B S P, Vol. 6, p 82, S. Key 234.

Evolution of major surgery

Relation between radiotherapy and surgery

used sometimes to produce spread of a growth along the raw surfaces of extraction. The basis of operative technique is that laid down by Trotter Gradual evolution has been made by better anaesthesia, control of infection and more understanding of the principles of plastic repair. Post-operative success is judged by the quality of breathing, swallowing, appearance and speech. Speech therapy is very useful after major mouth operations.

Gardham, A J. (1955). *Ann. R. Coll. Surg. Engl.*, 17, 291.

MUSCLE AND TENDON—DISEASES AND INJURIES

See also B S P, Vol. 6, p. 128, S. Key 235.

Malignant tumours of skeletal muscle

Research into the histogenesis

CONSTANCE (1955) writes on research into the histogenesis of the malignant tumours

parts highly pleomorphic Careful microscopic study of the anaplastic tumours, however, establishes their identity as fibrosarcomas, they show a variable amount of inter-cellular connective tissue, and the various transition stages between growths with a moderate amount

Constance, T. J. (1955). *J. Path. Bact*, 70, 365.

Pigmented villo-nodular tenosynovitis

Study of operative specimens from 34 cases

SHERRY and ANDERSON (1955) have studied the operative specimens from 34 cases of pigmented villo-nodular tenosynovitis and have compared them with a smaller series of ... In the tendon sheaths the lesion has been known as a giant cell ... consist ... emato- ... stroma, ... hs, but after fusion of the villi, the specimens were identical. ... ynovial-lined clefts, and scattered throughout were collections of pigment-stained macrophages. Enlargement of the tumour resulted in the formation of a fibrous capsule. Later there was gradual replacement of the cellular content by fibrous tissue, leaving nests of tumour cells. The variation in appearance of the 2 types is due to the confined space within which the tendon lesions must develop. The lesion is probably inflammatory in origin, the inflammation being a reaction to injury.

Sherry, J. B., and Anderson, W. (1955). *J. Bone Jt. Surg.*, 37A, 1005.

NECK—CYSTIC SWELLINGS OF

See also B.S.P., Vol. 6, p. 178, S. Key 238.

Branchial cysts

Surgical treatment

CONWAY and JEROME (1955) discuss the surgical treatment of branchial cysts and fistulas. A review has been made of 90 cases. Embryological studies demonstrate that countless possibilities for developmental errors exist, explaining to some extent the occasional unusual ... finding of thymic tissue within ... ather than genetic is ... es. A sinus diagnosed ... it may be determined ... ist also be considered. ... metastatic carcinoma, ... ed by the ... s of branchial cleft ... asions.

Conway, H., ... 1, 621.

NEOPLASMS—INNOCENT AND MALIGNANT

See also B.S.P., Vol. 6, p. 194, S. Key 240.

Dermoid tumours

Difficulties in diagnosis

Extra-abdominal dermoid tumours belong to the fibromatoses, and may cause much difficulty in diagno ... 8 such cases, and believes that it is essential for ... of tissue for microscopy. In large lesions, incr ... of treatment. The presenting ... to muscle but not to the skin. ... s ranged from 2 to 61 years. Six of the ... er, and 2 in the leg; they were firm,

yellowish, and lobulated, not encapsulated, and in each case they were infiltrating the surrounding muscles but with no direct invasion of bone. Microscopically they consisted of moderately cellular fibrous tissue, with typical adult fibrocytes, and rare mitotic figures. None were degenerate. At the advancing edge, most had entrapped muscle cells, which showed degenerative changes. There was never any attempt at encapsulation. The desmoids can be differentiated from sarcomas, by remembering that the latter are more cellular, have a strong tendency to encapsulate, and show numerous abnormal mitotic figures. Treatment consists of local excision, and as recurrences are no more malignant than the original tumour, they can easily be eradicated if they occur Four of the present series had local excision without recurrence, and one had a known incomplete removal to save involved vessels, and has had no further trouble. Two had the limb amputated, one because of a misdiagnosis, and the other due to vessel involvement. In the last case, a radical excision was performed, the tumour recurred after 3 years, and was re-excised. In no case was x-ray therapy used There is evidence in the literature to suggest that progesterone may have a place in treatment in the future.

Ramsey, R. H. (1955). *J. Bone Jt Surg.*, 37A, 1012.

Multiple neurofibromatosis

Disease groups and associated lesions

VENNER (1955) described the condition of multiple neurofibromatosis. This disease has been established as of a hereditary nature, with a family history clearly apparent in many cases although it may appear sporadically. The disease groups include cutaneous and generalized multiple neurofibromatosis, plexiform neurofibroma, elephantiasis neuromatosa; solitary neurofibroma, both cutaneous and in other sites. The condition has been described as one of "neuro-ecto-dermal dysplasia" and has a similarity to tuberose sclerosis The most

central nervous system are not common, but there is a comparatively high incidence of feeblemindedness. Malignant tumours may occur The treatment of the disease can only be palliative, the problems are mainly mechanical.

Venner, B (1955) *Aust. N.Z. J. Surg*, 25, 110

NERVES, PERIPHERAL—INJURIES

See also B.S.P., Vol. 6, p 218, S. Key 242.

Two-stage operation

Minimal traction injury

to complete loss of nerve function Any return of sensation in an anaesthetic area is useful and any

result of

Pollard, C., Jnr., and Grantham, E. G. (1955). *J. Neurosurg.*, 12, 627.

NOSE, NASOPHARYNX AND ACCESSORY SINUSES

See also B.S.P., Vol. 6, p. 271, S. Key 244.

Maxillary sinusitis

Treatment

Use of penicillin solutions.—ELSEN (1955) writes on the treatment of maxillary sinusitis by the use of penicillin solutions in the sinus. In one series of cases, maxillary sinus infections were taken consecutively without exceptions, whether acute, subacute or chronic. An aqueous suspension of penicillin G procaine, 600,000 units in 2 millilitres of sterile water, [illegible]

seven were clear after the second irrigation and 23 after a single irrigation and instillation. There were no instances of allergic reactions, nor evidence of any harmful effect on the nasal membranes.

Elsen, J. (1955). *Arch. Otolaryng., Chicago*, 62, 290.

ODONTOMES AND EPITHELIAL CYSTS

See also B.S.P., Vol. 6, p. 302, S. Key 245.

Epithelial cysts of the jaws

Adamantinoma

[illegible] years, with [illegible]

developed. The tumour was resected and then replaced by a prefabricated [illegible] prophylactic [illegible] was [illegible] that [illegible] ards [illegible] of a [illegible] onal [illegible] but there is a wide variation in the cellular morphology. As most adamantinomas are [illegible] resistant, excision of the affected area is the method of choice.

Holdsworth, W. G., and Rowe, N. L. (1955). *Brit. J. Surg.*, 43, 255.

Multiple dental cysts

Case report

KNIGHT and MANLEY (1955) report a case of multiple dental cysts A male patient aged 40 years had had all his teeth removed several months previously because of extensive dental caries; severe pain had been experienced in the left upper maxillary region, and pain and a thin discharge were present when he was first seen Examination showed an irregular [illegible] the malar buttress, and the external [illegible]

maxilla was removed and the cyst lining enucleated; it was noted at operation [illegible] wall of the antrum was so displaced medially as to almost obliterate the antral cavity. Histological study revealed proliferation of epithelium arising from the lining of the large cyst and extending into the fibrous connective tissue between the cyst and the bone, study of serial sections demonstrated several minute cysts in various stages of development.

Knight, J. S., and Manley, E. B. (1955) *Brit. dent. J.*, 99, 419.

OESOPHAGUS

See also B.S.P., Vol. 6, p. 304, S. Key 247.

Congenital oesophageal atresia

Diagnosis

NICKS and CAUGHEY (1955) describe congenital oesophageal atresia. Untreated, the condition is fatal, but in favourable circumstances, operation recovery rates of 50–70 per

absence does not exclude it. Pre-operative preparation is essential and repeated aspiration of the pharynx must be maintained Upon diagnosis, infusion of antibiotics should be

Nicks, R , and Caughey, R. H. (1955). *N.Z. med. J.*, 54, 682.

Regurgitant oesophageal ulcer

Symptomatology and treatment

SCHMIDT (1955) writes on regurgitant oesophageal ulcer, which mostly occurs secondarily to oesophageal hiatal hernia of the sliding type or to operations on the cardia. The oesophagus becomes short and usually strictured as a result of fibrosis in the muscular layers of the oesophagus, caused in turn by chronic oesophagitis. The symptoms include dysphagia, retro-sternal burning, epigastric pain, pyrosis, vor
findings will show the shortening of the oesopha
The oesophagogastric junction will be located at
If symptoms or roentgenologic findings suggest regurgitant ulceration at the oesophagogastric junction, oesophagoscopy should always be done to identify the lesion and to rule

must be done oesophagocardiomyotomy (modified Heller) is the safest procedure. In a review of records of a group of patients over a period of 10 years it was found that 9 underwent subtotal gastric resection, 5 had excellent results, 2 good results, and 2 had poor results

Schmidt, H W (1955). *Arch. intern. Med.*, 96, 717.

Carcinoma of the oesophagus

Palliative segmental resection

It has been stated that the performance of a palliative segmental resection in carcinoma of the oesophagus with its resultant correction of the associated dysphagia is justified because recurrence of tumour at the site of the anastomosis is a rarity even in those who eventually succumb to the disease. SCANLON and his associates (1955) analyse a series of 79 cases in which a segmental resection had been performed, to determine the incidence of inadequate longitudinal resections. There were 36 cases which could be placed in a determinate positive group consisting of those in which it was possible to demonstrate microscopically that carcinoma was present in the margins of the resected surgical specimen or that recurrent tumour was present at the line of the anastomosis either in a biopsy or the autopsy specimen Nine cases could be placed in a determinate negative group consisting of those with no evidence of carcinoma in the margins of the resected surgical specimen or of a recurrence at the line of anastomosis in the autopsy specimen, whilst 34 were placed

but a biopsy had not been obtained. Thus at least 45·6 per cent of these cases would appear to have had an inadequate longitudinal resection. In 17 cases this assumption was based solely on the [illegible]
was substant [illegible]
higher percer [illegible]
verse rather [illegible]
the survival rate of cases of carcinoma of the oesophagus is to be obtained, an extensive resection with removal of a greater portion of the oesophagus than is at present done should be carried out as a first stage with reconstruction undertaken at a later date.

Scanlon, E. F., Morton, D. R., Walker, J. M., and Watson, W. L. (1955). *Surg. Gynec. Obstet.*, **101**, 290.

OVARY

See also B.S.P., Vol. 6, p. 407, S. Key 254.

Ovarian tumours

Post-operative irradiation

GARDINER, LINDA and SLATE (1955) review 96 cases of malignant ovarian tumours in order to determine whether there is any advantage in the use of *post-operative irradiation* in various stages of the disease. In this series, the incidence was highest in women aged 50–59 years, whilst of the 78 married women, 18 had never been pregnant. A serous papillary cystadenocarcinoma was the commonest tumour and was found in 54 cases, a solid adenocarcinoma in 29, granulosa cell or anaplastic carcinoma each in 4, a pseudomucinous cystadenocarcinoma in 2 and a theca cell, malignant teratoma and sarcoma each in 1. Eighty per cent of the patients who survived 5 years had a serous papillary cystadenocarcinoma, but it appeared that the most important factor in prognosis was *not the histo-* [illegible] time of diagnosis. The overall [illegible] 3·7 per cent in Stage 1 cases to [illegible] the major factors contributing to the poor prognosis, but it was observed that those patients with symptoms of 12 months [illegible] period. Of the [illegible] n Stage 3, [illegible] these were [illegible] 1–2 weeks, [illegible] of 5 years and 10 of these [illegible] higher in those patients [illegible] and posterior fields. [illegible] by surgery would appear definitely to be increased by post-operative irradiation given in adequate dosage.

Gardiner, G. A., Linda, L., and Slate, Jean (1955). *Amer. J. Obstet. Gynec.*, **70**, 554.

Prognosis

Review of 88 cases.—HOLMAN (1955) discusses the prognosis of primary ovarian cancer based on a review of the 88 cases admitted to the U[illegible] between 1940 and 1951. The tumours were divided into 3 groups: [illegible] were 71 cases, the papilliferous cystadenocarcinoma [illegible] tumours of which there were 14 c[illegible] and an anaplastic teratoma. Eigh[illegible] of removal of the uterus, appendages [illegible] which were cases of embryonic tumours [illegible] but that of Group A was only 17 per cent compared with 75 for Group B. None of the [illegible] are still alive [illegible] rate of Group A was 40 per cent and of [illegible] of malignant ovarian tumours, it is suggested that embryonic and adenocarcinomatous tumours should be considered as separate entities.

Holman, J. C. (1955). *J. Obstet. Gynaec. Brit. Emp.*, **62**, 892.

Rhabdomyosarcoma

SANDISON (1955) describes a case of rhabdomyosarcoma of the ovary, mentioning that this is one of the rarest of neoplasms occurring in that organ; probably not more than 5

quality were seen scattered sparsely through a watery, pale eosin-staining, non-mucin-staining medium, which was much vacuolated. Abrupt transitions to areas of spindle-celled tumour tissue were noted, in which the cytoplasm was brightly eosinophilic. Many cells were distorted, but in others definite strap-like forms were assumed. The diameter of the striated

Sandison, A. T. (1955). *J. Path. Bact.*, 70, 433.

PANCREAS

See also B.S P., Vol 6, p. 433, S Key 257.

Pancreatic cyst

Pancreatic fistula

Hill and his colleagues (1955) discuss pancreatic ductal decompression, of which internal drainage of a pseudocyst by cystoenterostomy and cure of a chronic external fistula by its implantation into the jejunum are examples. Du Val (1954) described caudal pancreatico-

complicated by a faecal fistula Transection of the pancreatic tail was performed with pancreaticojejunostomy to divert the pancreatic flow from the fistula. After closure of the faecal fistula the patient was discharged.

Hill, R. L , Judd, C. S., Shaw, W R., and Boyar, W. T (1955) *Arch Surg., Chicago*, 71, 710.

Pancreatography

Investigation of 100 *cases*

Wirsung by means of a plastic tube. Radiological examination is carried out during the injection of 10 millilitres of the contrast medium The injection must be made slowly. Dilatation of the pancreatic duct system may be revealed by means of this technique. The dilated ducts may result from recurrent pancreatitis and long-standing spasm of the sphincter

compresses the plastic tube in the duct of Wirsung and the pancreatic duct system can be filled completely. The duct of Santorini was outlined by the pancreatogram in 39 per cent of the number of cases investigated by the authors. In 1 case the pancreatogram revealed a

through the diaphragm. Another patient was found to be suffering from abscess formation and cystic dilatation in the tail of the pancreas. No untoward effects resulted from the use of pancreatography.

Doubilet, H., Poppel, M. H., and Mulholland, J. H. (1955). *Radiology*, 64, 325.

Acute pancreatitis

Metabolic study

In acute pancreatitis there is an apparent
of
out
sta
pot
no effect. The injected calcium ions were at once cleared in the urine. A high serum lipase at this time suggested that the concomitant rise in serum fatty acids was reducing the amount of ionized calcium available in the blood. Administration of parathormone produced an increased excretion of phosphorus and a fall in the serum phosphorus, accompanied by a rise in
wore
returr
the tetany after parathormone therapy in this case, however, was associated with a normal fatty acid level, rapid fall in the serum lipase, decrease in the serum calcium, and a positive
sitive calcium balance
There was no change
nor suggests that the

Hayes, M. A. (1955). *Ann. Surg.*, 142, 346.

Diagnosis

intravenous secretin tests. In some cases the diagnosis was established either during the course of an operation or at necropsy. Another criterion was the presence of clinical manifestations of pancreatitis in a patient with more than 200 units of urinary diastase. Fat necrosis was observed in 11 cases Two patients suffered from post-operative pancreatitis. A cholecysto-jejunostomy was performed on a woman, aged 76 years, with obstructive

from a hydatid cyst
, but 6
ccurred
les and
due to
ncreas,
reatitis,
various authorities stress the importance of injury to the duct of Santorini and to the
may develop
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Joske, R. A. (1955). *Brit. med. J.*, 2, 1477.

Islet-cell tumour

Clinical features and treatment

Islet-cell tumour of the

GRIMSON and YELL (1955)

to the definitely malignant

drunk when first seen and was sweating slightly. These changes had occurred in a series

pancreas. The gland was removed and after a post-operative period in which insulin was needed to control the high blood sugar complete recovery occurred. The patient resumed work in a coal mine having been unemployable for 2 years. The tumour was a benign islet-cell adenoma.

Grimson, T. A., and Yell, Joan (1955) *Lancet*, **1**, 334.

PEPTIC ULCER AND ITS COMPLICATIONS

See also B.S.P., Vol. 6, p. 496, S Key 262.

Gastric ulcer

Post-operative occurrence of pulmonary tuberculosis

Causative factors.—ALLISON (1955) discusses 21 cases of pulmonary tuberculosis following subtotal gastrectomy. Starvation, mal-assimilation of food, metabolic imbalance and lowered resistance are the causative factors. In 17 patients, previous pulmonary tuberculosis was not evident, in 4, it had been inactive. Pre-operative anti-tuberculosis drugs reduced the mortality to 2. The interval between gastrectomy and the diagnosis of active tuberculosis ranged from 14 days to 14 years. The average 4-year interval represents the lapse of time between gastrectomy and contact with open tuberculosis, the time between infection and diagnosis or the time taken to overcome resistance. Before gastrectomy, x-ray screening is essential. Where tuberculosis is demonstrable, anti-tuberculosis drugs are indicated. After operation, 6-monthly x-ray examinations of the chest should be made for 5 years

Allison, S T. (1955). *New Engl. J. Med.*, **252**, 862.

Review of cases referred for surgery

BRAASCH, CAIN and PRIESTLEY (1955) review the records of the 50 patients who had had surgical treatment at the Mayo Clinic between 1940–46 for gastric ulcers within 2 inches of

logical study of the lesion itself. The large majority of the ulcers were situated on or near the lesser curvature, in these cases, although a variety of surgical procedures were employed,

gastroenterostomy would appear preferable to total gastrectomy or oesophagogastrectomy as a means of treatment. Three out of the 4 deaths in the series followed total gastrectomy.

Braasch, J. W., Cain, J. C., and Priestley, J. T. (1955). *Surg. Gynec. Obstet.*, **101**, 280.

Duodenal ulcer

Perforation into pancreas

Treatment.—Resection of a duodenal ulcer which has perforated into the pancreas is a difficult undertaking, and the many possible com[illegible] eased mortality rate. BAKER, BOYD, and Fo[illegible]
of the ulcer in the duode[illegible]
distal to the pylorus, and [illegible]
duodenal wall to the [illegible]
with omentum. They [illegible] cases in which the ulcer was resected T[illegible] duration of symptoms was longer in the excluded group, and believe that the longer history was responsible for the technical difficulties. Exclusion was performed relatively more frequently in the male, as duodenal ulcer is believed to be more severe in that sex. There were 3 deaths in the resection cases and only 1 in those with exclusion. Two of the former were due to [illegible] leakage also occurred in 2 cases with [illegible]
operative comp[illegible]
Dumping occ[illegible]
patterns of w[illegible]
view of these [illegible], the a[illegible]
it has eroded into the panc[illegible] extensive the penetration, the more scar tissue there is [illegible] closure, and in those cases in which the ulcer has opened the accessory pancreatic duct, the method imposes no danger of pancreatic fistula. They stress that the decision not to excise the ulcer must be made before any attempt has been made to remove it, for the success of the duodenal closure depends on an adequate blood supply to the pancreatic scar tissue.

Baker, J. W., Boyd, R. S., and Foster, R. A. (1955). *Ann. Surg.*, 142, 519.

Massive, acute, upper gastro-intestinal haemorrhage

Surgical management

WELCH, ALLEN and DON[illegible]
upper gastro-intestinal h[illegible]
[illegible]
wards. T[illegible]
of which [illegible]
cause po[illegible]
and depr[illegible]
at operat[illegible]
Pulmonar[illegible]
expeditious surgery; recurre[illegible]
imbalance, another importa[illegible]
[illegible]

[illegible], Allen, A. W., and Donaldson, G. A. (1955). *New Engl. J. Med.*, 252, 921.

Surgical treatment

Subtotal gastrectomy

METCALF, COOPER and S[illegible]
for peptic ulcer the op[illegible]

ɔeriod of about
and low-grade
ns in 203 cases,
36 cases. Major
disorders included duodenal fistula, stomal dysfunction, pneumonitis or atelectasis, and wound dehiscence or sepsis. A duodenal fistula developed on the fourth day in a man, aged 48 years, with a large duodenal ulcer which had penetrated deeply into the pancreas. Only 9 patients expressed dissatisfaction with the results of the operation. In evaluating the

Metcalf, P. B , Jnr., Cooper, P., and Smithwick, R. H. (1955). *Ann Surg.*, **142**, 924.

PERITONEUM AND PERITONITIS

See also B S P., Vol. 6, p 544, S. Key 264.

Acute chylous peritonitis

Clinical appearances and treatment

infection Some years before the patient had had an operation for tuberculous cervical glands. With good drainage the patient's pain ceased and convalescence was uneventful

provided a safety valve. At the second operation no sign of chylous leakage was seen so that the collateral channels had probably opened up by then.

Walker, J C. (1956) *Lancet*, **1**, 83.

PLEURA—DISEASES OF

See also B S P , Vol. 7, p 55, S. Key 270.

Chronic pleural empyema

Treatment

walls a surgical measure is necessary. With an intact and healthy lung thoracoplasty must never

the 2

feature

in the wall of the cavity. This calls for treatment by drainage. A series of 48 patients were treated by pleural decortication in the period 1947 to 1955. The average duration of the pleuritis was over 5 years; in 6 patients it had been present for over 10 years. All had tuberculous infections. The procedures were visceral decortication in 35 cases; visceral decortication with partial pleurectomy in 13; there was associated procedure on the pleura

subsequent thoracoplasty; 1 post-operative spread, 1 dead. Forty-four of the results were satisfactory; 4 unsatisfactory. Thoracoplasty has been found a better management for patients with a secondarily infected tuberculous pleuritis who are too ill for pleuropneumonectomy. A long-standing extrapleural pneumothorax, with or without a tuberculous infection of the space, represents a continuing hazard to the patient and should be closed

Kergin, F. G. (1955). *Ann. R. Coll. Surg. Engl*, 17, 271.

POLIOMYELITIS

See also B.S.P., Vol. 7, p. 94, S. Key 274.

Abductor paralysis of shoulder

Value of splinting

SHARRARD and KNOWELDEN (1956) report the results of an assessment of the value of abduction splinting, in relation to the principal aims of the splinting, in the treatment of abductor paralysis at the shoulder. Of 359 upper limbs of 230 patients, in whom some

respirator treatment had been necessary. No splinting after 6 weeks had been carried out *in 86 instances in which the deltoid muscle had been less severely affected.* After 18 months, irrespective of the age of the

one or both limbs, recovery

was found to be diminished

being: Group A, 15; Group

deltoid muscles graded 1 or

of the shoulder joint was fo

and sometimes harmful.

Sharrard, W. J. W., and Knowelden, J. (1956). *Lancet*, 1, 9.

PROSTATE

See also B.S.P., Vol. 7, p. 133, S. Key 278.

Prostatic median bar

Transurethral resection

Histology.—CLARKE and LATORRACA (1956) report the results of a histological clinical study of 17 cases of prostatic median bar treated by transurethral resection. The patients' ages ranged from 21 to 78 and each exhibited typical cysto-urethroscopic evidence of

addition there was oedema of the stroma which in the severest cases proceeded to fibrosis In no case was there significant histological evidence of an inflammatory process. These

Clarke, B. G., and Latorraca, R. (1956). *Arch. Path*, 61, 37.

Carcinoma of prostate

Orchidectomy and stilboestrol therapy

GANEM (1955) evaluates the results of the treatment of carcinoma of the prostate by means of orchidectomy and stilboestrol therapy. The author bases his observations upon a study of 221 cases with particular reference to the number of patients who were alive 5

Ganem, E. J. (1955) *J. Urol.*, 74, 804.

Prostatectomy

Radical retropubic

Results of operation.—ATHERTON and ATHERTON (1956) report on the results obtained with radical retropubic prostatectomy in the management of 30 cases of prostatic carcinoma and 21 cases of conditions such as prostatitis. Twelve patients were alive and free from disease 22–65 months after the operation. Within this period there were 4 deaths due to carcinoma and 2 deaths due to pulmonary embolism. One patient with unsuspected tuberculous prostatitis died from miliary tuberculosis. The authors recommend the use of

over a gauze sponge. By means of the operation satisfactory urinary control becomes established within an average period of 1 week. Hormone therapy is not required for patients with a small area of carcinoma which is well confined within the prostatic tissue. Orchidectomy should be performed for local recurrence of the disease and when metastases occur

Atherton, L., and Atherton, L. D. (1956) *J. Urol.*, 75, 111.

controlled rapidly and easily by haemostatic forceps

from hospital has not been encountered. Meatal stenosis following all types of prostatectomy would seem to have been more frequent recently; this may possibly be due to the use of antibiotics, but the size of the catheter used is another factor in its production. Although statistics all point to the rarity of osteitis pubis before the retropubic operation became popular, this condition is by no means limited to this operation. Its pathology remains unsolved.

Kirkland, K. (1955). *Med. J. Aust.*, 2, 921.

Suprapubic prostatectomy

Morbidity.—HARRIS (1955) discusses morbidity associated with the operation of suprapubic prostatectomy with closure. This operation is not one for the occasional prostatectomist as the details of the operation play a very great part in reducing mortality and morbidity. A nice clean intracapsular removal of the prostate is essential. In the author's hands, mortality and morbidity are now extremely low due in large measure to adequate treatment in hospital as a prelude to operative interference. Incisional hernia is rarely seen as the suprapubic incision is small, whilst the high opening in the bladder and method of closure make urinary fistula rare. Osteitis pubis has not been encountered. The positive haemostasis results in relative freedom from reactionary and secondary haemorrhage from infection. Efficient retrigonisation is an absolute preventive to post-operative bladder neck obstruction. Post-operative obstruction has at times occurred in patients with a protuberant abdomen [illegible]

[illegible]

[illegible]

to failure to remove all the obstruction. Urinary continence is the rule from the time the catheter is removed, but re-education of the bladder to increase its capacity may be necessary. Epididymitis despite vasotomy is still a worrying complication, whilst urethral stricture has been seen following trauma from catheterization.

Harris, R. G. S. (1955). *Med. J. Aust.*, 2, 917.

Transurethral resection

Morbidity.—MORTENSEN (1955) discusses morbidity following prostatectomy by transurethral resection. In a series of 950 patients with clinically benign prostatic obstruction [illegible] only 3 deaths

[illegible]

[illegible]

[illegible] mission to hospital for relief

[illegible] occurred in less than 1 per

[illegible] ymo-orchitis was practically

eliminated by vasotomy. Post-operative stricture of the urethra occurred in 7 per cent, but only the occasional case needed constant and permanent sounding. This complication, according to Carlson, may be associated with long continued use and immersion of the instruments in sterilizing solutions for long periods, as, with the purchase of a new instrument, the occurrence of strictures virtually disappears for a while. No obvious case of haemolysis has been seen in the last 500 cases. Provided obvious precautions are taken against haemolysis, the use of sterile water is preferable to isotonic solutions. In this series, no instance of permanent incontinence was seen. Post-operative infection of the urine in most cases cleared with the epithelialization of the prostatic cavity and required no active treatment. Its degree was relative to the completeness of the resection.

Mortensen, H. (1955). *Med. J. Aust.*, 2, 919.

PULMONARY TUBERCULOSIS

See also B.S.P., Vol. 7, p. 197, S. Key 281.

Treatment

Segmental and wedge resection; lobectomy and pneumonectomy

BROWN, DRASH and MINOR (1956) discuss the use of segmental and wedge resection, lobectomy and pneumonectomy in the treatment of 106 patients suffering from severe [illegible] with those obtained in a series

[illegible] employed in cases

[illegible] ation was the most

[illegible] y there was some

[illegible] disease when the

[illegible] tal the

operation was performed on the righ[illegible] atients

case fatality for Group 1 was 4·7 per [illegible]

and when the sputum is no longer infective. In these circumstances it is unnecessary to

may improve the eventual course of the disease, especially when the residual nodules are more than 2 centimetres in diameter.

Brown, L. B, Drash, E. C., and Minor, G R. (1956). *Amer. Rev. Tuberc.*, 73, 79.

RECTUM—BENIGN TUMOURS OF

See also B S.P, Vol 7, p. 319, S. Key 289.

Villous tumours

Radical approach in treatment

whilst in 2 cases of malignancy with metastases, the patients were treated for palliation by desiccation and radiation. In the remaining 16 patients, 3 tumours were excised surgically after delivery through the anus, 1 which proved to be a carcinoma *in situ* was excised locally by colotomy, and the remainder were treated from below by desiccation alone after snare

1 indistinct, subse-
11 times, but the
tients, all but one
peration. Provided

the adjacent mucous membrane as well as the tumour are thoroughly treated, removal from below by thermal or surgical means would appear to be an adequate method of treating low rectal papillomas which have a small base and show no invasion of the basement membrane.

Freund, N. L. (1955) *Amer J. Surg*, 90, 873.

SALIVARY GLANDS

See also B.S P., Vol 7, p 430, S. Key 298.

Parotid gland

Fatty infiltration simulating mixed tumour

A case of fatty infiltration of the parotid gland forming a nodule that could not be differentiated clinically from a mixed tumour of the parotid, is reported by GILMAN,

Gilman, R. A., Schwartz, M., and Gilman, Janet S. (1956). *J. Amer. med. Ass*, 160, 48.

Sialoangiectasis

Bisgard and Kimball (1955) discuss the pathology of sialoangiectasis of the parotid glands. This condition is characterized by gross cystic dilatation of the ducts and alveoli not associated with obstruction of the ducts as a result of calculi, stricture or tumour. It may, however, be associated with the presence of masses of lymphoid tissue in the gland substance, either diffuse or localized, and containing foci of epithelial cells probably originating from the parotid ducts. The histological picture may be suggestive of lymphosarcoma. The differential diagnosis is discussed and also the treatment of previously reported cases by either excision, or excision followed by irradiation. The assessment of these methods is difficult because it was not always clear whether the lympho-epithelial lesions were associated with sialoangiectasis or not. The authors report a case of bilateral sialoangiectasis in a woman aged 55 years. A right parotid swelling had been present for 7 years and a left parotid swelling for 1 year. Bilateral drainage had previously been performed. Sialograms showed bilateral cystic and saccular sialoangiectasis. Bilateral total parotidectomy with preservation of the facial nerve was carried out at two operations. The interval between the right and left parotidectomy was 3 years because of the patient's initial refusal to have a second operation. Histologically both glands showed dilated ducts and a large mass of lymphoid tissue with well developed germinal centres and dilated lymphatic channels. Several cysts between 5 and 10 millimetres in diameter were present containing clear fluid and lined by squamous epithelium.

Bisgard, J. D., and Kimball, K. (1955). *Arch. Surg., Chicago*, **71**, 337.

Acute suppurative parotitis

Treatment

Pulaski and Keeling (1955) report 2 cases of acute suppurative parotitis in men, 1 following pancreatic fistula, the other, areolar abscess in the right breast. In the first the purulent discharge from the abdominal wound grew on culture, *Staphylococcus aureus*, alpha-haemolytic streptococci and *Aerobacter aerogenes*. A month later, bilateral parotitis developed. After erythromycin therapy with concurrent irradiation, the parotid swelling disappeared and the abdominal leakage ceased. In the second case, oral tetracycline was given and the abscess drained. Cultures grew coagulese-positive *Staph. aureus* sensitive to bacitracin, chloramphenicol and erythromycin. Two days after leaving hospital, a purulent bilateral parotitis developed. Aspiration and chloramphenicol instillation produced rapid improvement. Culture of the aspirates revealed *Staph. aureus*. A few days later, necrotic parotid tissue presented and was removed. Recovery was immediate and cultures were negative.

Pulaski, E. J., and Keeling, W. M. (1955). *New Engl. J. Med.*, **253**, 1028.

SPINAL COLUMN

See also B.S.P., Vol. 7, p. 539, S. Key 306.

Traumatic paraplegia

Results of late laminectomy

Hagelstam (1955) describes the results of late laminectomy in 48 cases of traumatic paraplegia, treated since 1943. In 26 cases the cause was closed fractures of the spine and in 22 it was open war injuries. Four patients had cervical injuries, 8 had dorsal lesions, 30 were located to the thoraco-lumbar region and 6 were pure cauda equina [illegible] cases an obvious compression of the cord or cauda equina [illegible] able result of the operation was noted. In no ca[illegible] or materially postponed the rehabilitation progr[illegible] ment of function—motor, sensory or bladder—m[illegible] a very good influence on the patient's psychical co[illegible] active attitude towards his rehabilitation programme [illegible] and he is stimulated to have a more at a late stage if the patient has not had the advantage of being operated on earlier. Since complete anatomical transection of the cord cannot be diagnosed clinically all traumatic spinal cord lesions should be explored as soon as possible after injury. Traumatic paraplegia *per se* has been the indication for surgery in the author's hospital and laminectomy has always been carried out when not contra-indicated. Most of the patients have been observed long enough for the result of the operation to be judged. Only 5 of the 22 patients with open injuries and 7 of the 26 with closed injuries were observed for less than 6 months after operation.

Hagelstam, L. (1955). *Acta chir. scand.*, **110**, 218.

Vertebral osteochondritis

Pathology, clinical symptoms and treatment

cartilage and bone appear, enlarging and fusing into a flattened ring, constituting in man an apophysis rather than an epiphysis The apophyseal bony centres first appear, about the

common ligament. Growth thus ceases in the anterior parts of the bodies, increasing the deformity due to bone destruction and increased pressure. Lumbar osteochondritis is often only revealed by radiography. The changes, occurring alone or with thoracic involvement, show extensive collapse of cartilage with a major disc protrusion separating part of the apophyseal rim. Increase in antero-posterior diameter of the affected body is diagnostic

or games in a few weeks. The lesions gradually heal and, when growth is complete, the

the incidence among country boys doing heavy farm work. A congenital and familial aetiology, put forward by Kemp and Wilson (1947), is interesting but not convincing.

Butler, R. W (1955) *Proc R Soc Med.*, 48, 895.

SPINAL CORD

See also B S P, Vol 7, p. 572, S Key 307.

Spinal canal

Dilatation at thoraco-lumbar junction

Jefferson, A. (1955). *J. Neurol. Neurosurg. Psychiat*, 18, 305

Tumours

Compression of spinal cord

Early detection —The early detection of compression of the spinal cord by new growths is discussed by ROWBOTHAM (1955) In a period of 8 years he saw 80 such cases of which three-quarters were primary growths An analysis was made to determine whether diagnosis might be possible without using dangerous or distressing methods of investigation. Forty-six

tumours were derived from the tissues of the spinal cord and the ...
36 tumours was possible only ...
mats and neuromats were cor...

... to 60 milligrams per 100 millilitres with limb weakness should excite suspicion A negative Queckenstedt's test does not exclude tumour and to wait for evidence of bone damage may be disastrous. Angiomats may be clinically indistinguishable from meningiomats and neuromats but may greatly damage the cord without causing blockage or change in the ...

... itself and the presence of blood in the fluid is thus wrongly interpreted. Spina bifida with signs of compression suggest embryoma. Root pain is a common sign of growth arising in the posterior walls of the body cavities and operation for these can rarely be more than palliative.

Rowbotham, G. F. (1955). *Lancet*, 2, 1220.

SPLEEN—SURGERY OF

See also B.S.P., Vol. 8, p. 1, S. Key 308.

Splenectomy

Indications and results

COLLER (1955) discusses the spleen and some of its diseases that may be treated by surgery. A study has been made of a series of patients treated by splenectomy during the period 1934–55. The results have ...
surgeons in defining the ir...

... rimary hypersplenism; these ... 52 of congenital haemolytic anaemia, 1 of primary splenic neutropenia (without arthritic manifestations), and 2 of splenic pancytopenia. Th...
comprising 32 congestiv...
disease and 1 of infectio...
of idiopathic acquired h...
anaemia. The operation ...
comprising 3 cases of splenomegaly of undetermined aetiology, 2 of cyst, 2 of sarcoidosis and 6 of miscellaneous conditions. An analysis of the results shows that surgical measures are most ... Felty's syndrome ...
may be ...
spleen, tl...
advised. ...
cytopenic purpura and acquired haemolytic anaemia, the drugs appear to be equally effective when given in doses of 100 milligrams of ACTH or 300 milligrams of cortisone daily. The use of steroid therapy may obviate the need for splenectomy in selected cases. These drugs have little to offer in cases of congenital haemolytic anaemia, as splenectomy is so specific in this disease, they may, however, occasionally be of value in controlling haemolytic crisis or in the preparation of patients for subsequent operation. Other points of special importance in pre-operative preparation, in addition to the usual general measures, include: adequate blood volume, appropriate antibiotics, especially in cases of splenic neutropenia, pancytopenia, or Felty's syndrome, gastro-duodenal intubation; use of the proper anaesthetic. An analysis of the author's cases showed an excellent clinical response in 71·5 per cent; total failure (immediate or early death without improvement) in 17·9 per cent; 10 6 per cent of the patients survived the operation but derived little or no benefit from splenectomy.

Coller, F. A. (1955). *Ann. R. Coll. Surg Engl.*, 17, 335.

Rupture of the spleen

Radiological diagnosis and treatment

PAYNE (1955) describes a case of splenic rupture in a woman aged 55 years. The patient gave a history of falling against a settee. The accident was forgotten after a few days of pain in the left side and difficulty in breathing. During a routine examination 14 days later it

performed and the ruptured spleen was removed. The spleen was found to be surrounded by a large haematoma There was no evidence of either splenic disease or serological abnormality

Payne, W. J (1955) *Brit. med. J*, 2, 1370

STOMACH—DISEASES OF

See also B S.P., Vol. 8, p 49, S. Key 312.

Partial gastrectomy

Complications

The complications of partial gastrectomy are discussed by STAMMERS (1955) The author stresses the paramount importance of pre-operative physiological balance; post-operative balance is even more important, and it is therefore assumed that every patient, either in the theatre or immediately on return to the ward, is placed on gastric suction (Ryle's tube),

down and become a reservoir for bile and pancreatic juices, preventing them from being admixed with food and so causing steatorrhoea

Stammers, F. A. R. (1955) *Ann. R. Coll. Surg. Engl*, 17, 373.

Benign gastric tumours

Diagnosis

Benign gastric tumours are rare, and usually only seen at autopsy, they may present difficulties of diagnosis during life LUND (1955) records 10 such cases of ages from 36 to

In 4 the bleeding was massive, 2 had palpable swellings, and all were diagnosed as carcinomas. At operation the tumours were all at a distance from the curvatures of the stomach, and were up to 8 centimetres in diameter Three of the cases had a gastrectomy, in 2 the tumour only was removed. There was 1 operative death, the other 4 being well after at least 2 years.

Lund, R (1955). *Acta chir scand*, 109, 407.

SUBPHRENIC ABSCESS

See also B S P, Vol 8, p. 104, S Key 314

Spread of infection to chest

Study of series

HARLEY (1955) discusses subphrenic abscess with particular reference to the spread of

types of abscesses showed 171 intraperitoneal, 14 extraperitoneal, 2 combined and 1 unknown. [illegible]
to [illegible]
the [illegible]
resultant pyelophlebitis. Two forces probably account for this movement of peritoneal fluid; gravity, when the patient is recumbent, and hydrostatic pressure when he is upright. Once infected fluid reaches any part of the diaphragm it is likely to spread over its surface by the constant movement occurring between the diaphragm and its related viscera. No evidence was found to suggest that spread of infection [illegible]
lymphatic pathway [illegible]
spaces, especially tl [illegible]
infection across the [illegible]
such as rupture of [illegible]
the abscess, or a pe [illegible]
lymphatic spread in the conduction of infection to the chest. Serous pleural effusions result from the out-pouring of an inflammatory, but non-infective, exudate caused by dilatation of the minute vessels under the diaphragmatic pleura. They have a different mode of origin [illegible] ot be considered as harbingers [illegible] the 188 patients; of the 60 on [illegible] ema, which was considered to have been caused by the procedure.

Harley, H. R. S. (1955) *Ann. R. Coll. Surg. Engl*, 17, 201.

TESTICLE AND TUNICA VAGINALIS

See also B.S.P., Vol. 8, p. 174, S. Key 320

Epididymitis

Combined therapy

FLORENCE (1956) states that the management of epididymitis consists in rest, elevation of the scrotum and the administration of analgesics and antipyretics. At first cold should [illegible]

biotic therapy with cortisone therapy. Florence describes 5 cases in which combined therapy proved to be successful. For example, a man aged 23 years with acute epididymitis was given routine treatment as well as cortisone, penicillin, streptomycin and achromycin. Complete recovery was effected in 6 weeks.

Florence, T. J. (1956). *J. Urol.*, 75, 133.

Imperfect descent

Passage of testicle into a superficial inguinal pouch

MACNAB (1955) describes maldescent of the testicle. Recognition of a superficial inguinal pouch acting as an abdominal portion of the scrotum (Browne, 1933) has revolutionized treatment. The testicle, emerging from the external abdominal ring, may pass down into the scrotum proper or turn upwards and outwards to occupy this abdominal extension, believed to be a developmental remnant of a mechanism providing the low-temperature environment essential for spermatogenesis. Testosterone, the internal secretion of the testicle, is responsible for the secondary sexual characteristics of puberty, but does not activate spermatogenesis. This stimulus originates in the anterior lobe of the pituitary, where 2 forms of gonadotrophins have been isolated. The testicle begins to develop at the sixth week of intra-uterine life and rapidly descends to the inner aspect of the internal abdominal ring, where it remains until the seventh month, reaching the scrotum during the eighth month. A palpable testicle must lie in the normal or in the "primitive" scrotum, the so-called ectopic testicle lying in the latter. The only true ectopic form arises when the testicle occupies the superior ingu [illegible]
pubis, constituting a barrier to de [illegible]
laterally and cannot be palpated [illegible]
testicles can be massaged into a [illegible]
will occur by the fourth year. In this series of 350 cases, 75 per cent were palpable in the superficial inguinal pouch and in 95 per cent could just be massaged over the symphysis pubis. Operation should be reserved for cases where this manoeuvre cannot be achieved by the age of puberty or where the testicle is impalpable. Increasing knowledge in assessing

fertility by examining the seminal fluid seems to justify exploratory operation at the age of 12 years, with a view to bilateral orchidopexy. The presence of a hernial sac, however, is a complication. In this series, 43 were treated by concurrent herniotomy and orchidopexy, irrespectively of age. Torsion and pain in undescended testicle are rare. It is, however, highly sensitive and liable to trauma, particularly at games. Hormonal therapy, 4 intra-

Macnab, G. H. (1955) *J. R Coll. Surg Edinb*, **1**, 126.

THROMBOSIS AND EMBOLISM

See also B S.P., Vol. 8, p. 234, S. Key 324.

Thrombosis in malignant disease

In pancreatic adenocarcinoma, bronchial carcinoma and ovarian teratoma

brain, kidneys and spleen, and terminal thrombosis of deep veins of right calf with pulmonary embolism The second case had an anaplastic squamous carcinoma of bronchus with a solitary metastasis in the pons, fibrin vegetations on mitral and aortic valves, with embolism and infarction of myocardium, spleen, kidneys, pituitary, liver and skin In the third case there was a malignant ovarian teratoma, with secondary deposits in liver, abdominal lymph nodes and 1 adrenal, thrombotic vegetations on mitral valve, with old and recent infarcts in

thrombotic vegetations occasionally found in such states it does not explain their formation early in the primary disease, before infection or cachexia are prominent, nor indicate why

that

that

anti-

Smith, J P, and Yates, P O (1955) *J. Path. Bact*, **70**, 111

THYROID GLAND—DISEASES OF

See also B S P., Vol. 8, p. 256, S Key 257.

Malignant tumours

Relationship of lymphosarcoma and Hashimoto disease

Examination showed unilateral or bilateral enlargement of the thyroid gland, the swelling was usually firm and some cases showed fixation of the gland Operation revealed adhesions, and invasion of surrounding tissues Cervical lymph-node metastases were found in 4 cases and distant metastases in 4 cases Treatment consisted of subtotal thyroidectomy in 6 cases and total thyroidectomy in 2 cases, with irradiation in 7 cases In 2 cases the patients are alive and well 19 months and 8 years, respectively, after the onset of symptoms, a third patient has survived 10 months, but has a residual tumour; 5 patients died 3–10 months after the onset of symptoms. The thyroid glands in 7 of the 8 cases exhibited the simultaneous occurrence of a malignant lymphoma and the classic lesions of Hashimoto disease. The Hashimoto process was diffuse in 4 cases and focal in 3; it was noted in thyroid lobes uninvolved by the tumour and in residual segments of thyroid lobes invaded by the lymphoid neoplasm. These Hashimoto lesions showed characteristic epithelial

alterations in addition to diffuse or focal lymphoid infiltration. In 1 case in the series, the clinical and pathological findings indicated that the onset of a growing thyroid tumour 1 year before had been preceded by thyroid enlargement of 4 years' duration, the result of hyperinvolution and extensive Hashimoto disease. The benign lymphoid tissue and the neoplastic lymphoid tissue showed distinctly different histological and cytological appearances; cellular pleomorphism, mitotic activity and marked invasion characterized the malignant tissue, while lymphoid follicles, and a close relationship to small thyroid follicles with Askanazy changes in the epithelial cells were typical of Hashimoto disease.

Lindsay, S., and Dailey, M. E. (1955). *J. clin. Endocrin.*, **15**, 1332.

Carcinoma of the thyroid in children

Treatment.—Childhood thyroid carcinoma is discussed by BUCKWALTER (1955). Among 79 new patients with carcinoma of the thyroid, seen during a period of 5 years, 8 (10.1 per cent) were under the age of 15 years, indicating that this lesion has an age incidence quite different from that of other malignant neoplasms. The series of 8 children comprised 4 females and 4 males; their ages at onset ranged from 7 to 14 years: the intervals prior to treatment varied from 1 to 24 months, the site of the presenting lesion was the thyroid in 5 cases and a node in 3 cases. The results of a follow-up study shows that 7 of the patients are cancer-free, after periods varying from 2 months to 5 years; 1 patient died from the neoplasm after 7 months. In 3 instances, external irradiation had been administered during infancy, for the treatment of an enlarged thymus, 2 siblings of 1 of these patients died during infancy, allegedly because of an enlarged thymus, each of them having received irradiation therapy, and the possibility that the masses treated were thyroid lesions cannot be entirely excluded. An enlarged cervical lymph node was the first clinical manifestation in 3 cases; the lesions in 2 of these cases were predominantly follicular adenocarcinomas and in the other it was a papillary adenocarcinoma. The results of thyroid function tests suggested a euthyroid state. Operation revealed lymph-node involvement in 7 cases (bilateral in 5): 1 case showed direct invasion of the trachea, pre-thyroid muscles were involved in 4; no gross neoplasm remained after definitive surgery in 4 cases. The microscopic diagnosis was follicular adenocarcinoma in 4 cases, papillary carcinoma in 3, and small-cell carcinoma in 1. In most instances, the primary treatment was complete surgical extirpation of the gross neoplasm; tracheotomy was performed in 3 cases. The post-operative morbidity was low and there was no mortality. Radioactive iodine was the most valuable method of adjunctive therapy. Any non-tender mass in the thyroid gland or cervical region of a child, without upper respiratory infection or exanthem, should be considered as carcinoma until disproved by biopsy. The majority are differentiated lesions, more frequent in younger patients and marked by a prolonged course and late metastases, the undifferentiated lesions are characterized by early metastases and a progressive and usually fatal course. The results obtained with radio-iodine in the present series justify its further use.

Buckwalter, J. A. (1955). *J clin Endocrin*, **15**, 1437.

Results of conservative operation

The results of conservative operations for malignant tumours of the thyroid are discussed by CRILE, SUHRER and HAZARD (1955). A review has been made of all the malignant tumours of the thyroid seen by the first author during the period 1937–54; of 182 such tumours, 59 per cent were papillary carcinomas. Patients with papillary carcinoma comprised a *secondary group* of 33 who had had a previous operation on the thyroid and a *primary group* of 74 who had not had a previous operation on the thyroid itself but which included 23 who had had neck dissections or biopsies of cervical nodes. An analysis of the extent of disease found at the authors' operations showed carcinoma in thyroid and cervical lymph node metastases in 47 primary and 22 secondary cases, carcinoma in thyroid without cervical lymph node metastases in 27 primary cases only, lymph node metastases without carcinoma in thyroid in 11 secondary cases only, and distant metastases in 4 primary and 3 secondary cases. The types of operation used included partial or total lobectomy; subtotal or total thyroidectomy, unilateral or bilateral removal of lymph nodes only; palliative excision of part of the thyroid tumour, excision of a solitary cervical lymph node or mass; and biopsy only. The data show that excellent results may be achieved by conservative operations on most papillary carcinomas and their follicular variants if the primary tumour is completely excised and the grossly involved lymph nodes are removed. A papillary carcinoma is, apparently, often disseminated and rendered incurable by biopsy or partial excision. In non-papillary carcinomas, the results depend more on the type of tumour than on the type of treatment. The study suggests that radical mutilating surgery is seldom if ever indicated in these cases.

Crile, G., Jnr., Suhrer, J. G., Jnr., and Hazard, J. B. (1955) *J. clin Endocrin*, **15**, 1422.

Treatment of metastatic carcinoma with radio-iodine

MALOOF, VICKERY and RAPP (1955) present an evaluation of various factors influencing the treatment of metastatic thyroid carcinoma with I^{131}. They survey a group of 21 selected patients with these growths. The primary tumour was classified as adenocarcinoma arising in an adenoma in 10 patients; as follicular adenocarcinoma in 5, as mixed papillary and follicular in 4, as pure papillary in 1, and as Hurthle-cell adenocarcinoma in 1. Surgical total thyroidectomy was performed in 15 patients. Following this an uptake of I^{131} was induced in the metastases of 7 of the 15 and was increased in the metastases of 5 other patients

associated with growth of the metastases resulting indirectly from TSH stimulation. This may outweigh the benefit deriving from increasing the avidity of the tumour for I^{131} Since the effect of anti-thyroid drugs in increasing the I^{131} uptake may be diminished once radio-
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of the isotope in the metastases Concerning functional variations it appears that certain

hormone from a portion only of the tumour mass. However, such variations in the same patient may defeat the attempt of the physician to treat the lesion successfully with I^{131}.

URETER—TRANSPLANTATION OF

See also B S P , Vol 8, p 370, S. Key 335.

Uretero-ileostomy

Post-operative examination by pyelography

READ
Multiple
problems
ureters into an isolated segment of the gastro-intestinal tract and to construct continent artificial urinary reservoirs, have not been satisfactory. In 1952, Bricker reported 55 cases of uretero-ileostomy, with an operative mortality of 3 2 per cent Pyelograms were reviewed in terms of "renal units", of 35 normal pre-operatively, 71 per cent were "satisfactory" after surgery, particularly regarding nephrosis. Pyelonephritis occurred in 28 per cent cases, hyperchloraemic acidosis was absent The authors have performed the Bicker type of operation on 6 patients with favourable results The cases are reported, the sixth demonstrating that uretero-ileostomy is a feasible secondary procedure which may be undertaken when renal failure threatens Pyelograms revealed that 6 of 7 renal units, normal before diversion, maintained normal function subsequently, in only 1 case were hydro-ureter and hydronephrosis evident Pre-operative obstruction returned to normal in 3 of 5 units; pyelonephritis occurred in 1 case Hyperchloraemic acidosis was not observed. The operative procedure is a modification of Bicker's The ureters are transplanted into a short ileal loop,

end-to-side anastomoses are performed by the mucosa-to-mucosa technique; purse-string sutures stabilize the catheter, preventing leakage of urine and enabling urine volumes to be accurately measured.

Read, G. R., and Hurwitz, A. (1955). *New Engl. J. Med.*, 252, 341.

Uretero-sigmoidostomy

Post-operative complications

[illegible]

therefore, even at the expense of continence. An isolated ileal segment to carry the urine to a surface bag vies with the alternative of a rectal bladder, constituting a low pressure, sterile, continent reservoir. Reflux of faeces-contaminated urine after transplantation, produces upper tract dilatation, pyelonephritis, renal damage and hyperchloraemic acidosis. Reflux depends largely upon patent ureteral orifices and difference between high rectal voiding pressure and lower ureteral secretory pressure Rectal defaecation pressure is mainly due to the action of the diaphragm and abdominal muscles on straining. Colostomy makes straining unnecessary. Moreover, material is prope [illegible] pressure by peristalsis throughout the cc [illegible] patient with a rectal bladder voids at low [illegible] High voiding pressure in the presence of [illegible] secondary effects [illegible] with no recurrence of pyelonephritis n [illegible] results from increased reabsorption of [illegible] kidney to excrete them. After uretero-sigmoidostomy, urine can travel up the colon to the caecum Colostomy reduces the area exposed to urine and should reduce reabsorption Since acidosis cannot be corrected once renal damage exists, colostomy should be done concurrently with uretero-sigmoidostomy Similarly, since sterilization of the rectal segment would eliminate pyelonephritis, antibacterial therapy, as well as colostomy, is indicated at the time of ureteral transplantation. The choice between a stoma in the abdominal wall and a colostomy is a difficult one. The authors, however, feel that a rectal bladder with sigmoidostomy offers a *practical substitute for the normal organ and advise early sigmoidostomy.*

Smith, G I, and Hinman, F., Jnr. (1955). *J. Urol*, 74, 354.

URETHRA AND BLADDER : CONGENITAL MALFORMATIONS

See also B.S.P, Vol. 8, p. 383, S. Key 336.

Diverticulum of the anterior portion of the urethra

Clinical examination and urethrography

[illegible] abscesses during the previous 5 years He presented with a subacute [illegible] ry infection. Urethro- [illegible] he anterior portion of [illegible] He was treated by periodical dilatation and became symptom-free Case III, aged [illegible] years, had undergone surgical operation 5 years previously when suprapubic and perineal suppuration had been [illegible] Eighteen months later the prostate was resected and vesical calculi removed. He [illegible] is performed.

Murphy, L. (1955). *Med. J. Aust.*, 2, 922.

URETHRA—NEW GROWTHS AND STRICTURE

See also B.S.P., Vol 8, p 407, S. Key 337.

Neonatal obstruction

Diagnosis

Urethrography.—STEPHENS (1955) writes on urethral obstruction in childhood and the use of urethrography in diagnosis Over a period of 5 years a series of 175 patients whose ages ranged from newborn to puberty were studied, on whom 241 micturition-cysto-urethrograms were made, some of them post-operative. Of these, 103 showed normal urethrograms with or without upper urinary tract abnormalities In 32 cases congenital

bulbo-cavernous muscle. Also it was possible to display the effective action of the external sphincter which is distributed over a greater length of urethra in children than is usually described for adults. This method also showed that, by comparison, the internal sphincter occupied a very short band These zones were checked by corresponding micro-anatomical studies. Correlation of the urethrographic criteria of valvular obstruction with the actual post-mortem specimens of this disease led to a more detailed study of the normal and

was completely bifurcated when the valves arose directly from the verumontanum. Consequently, it could be postulated that valves were abnormalities of this crest and that the crest developed as a bilateral structure. Further evidence as to the origin of the terminal fins and the inferior urethral crest was suggested by the study of 1 post-mortem case of a newborn male infant in whom the kidneys and all structures derived from the Wolffian ducts were lacking In this urethral specimen, the verumontanum was slightly elongated, but the inferior crest and fins were absent The absence of the fins and crest in this 1 case suggested that these structures may well be intimately associated with the development of the Wolffian ducts, that they represent traces of the terminal ends of these ducts which during development are taken up into the urogenital sinus, transferring the orifices from their original sites near the cloacal membrane to the final position on the verumontanum,

corresponded to the external sphincter and to that sleeve of involuntary muscle which lies internal to this structure Urethrography further suggested that during voluntary attempts to micturate the zone of the sphincter occupied by the internal sphincter might actually widen

Stephens, F. D (1955) *Aust. N Z J. Surg*, **25**, 89

UTERUS—CERVIX; AND VAGINA

See also B S P, Vol 8, p. 451, S. Key 341

Carcinoma of the cervix

Reappearance 30 years after treatment, case history

HOWKINS ar
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yearly until 1939 and no evidence of a recurrence was observed. In 1954 she returned with a history of vaginal bleeding for 3 days' duration. A friable ulcer was found eroding the

atrophied cervix and infiltrating the vaginal vault, and was confirmed by biopsy to be a fairly well-differentiated squamous-celled carcinoma. Although great technical difficulty was encountered due to dense masses of adhesions, a Wertheim's hysterectomy was successfully performed. As the original biopsy section cannot be traced, the aetiology in this case remains obscure.

Howkins, J., and Andrews, J. D. (1955). *J. Obstet. Gynaec. Brit. Emp.*, **62**, 870.

VASCULAR SURGERY

See also B.S.P., Vol. 8, p. 489, S. Key 343.

Acquired tricuspid stenosis

Clinical diagnosis and treatment

CHESTERMAN and WHITAKER (1955) describe the diagnosis and surgical treatment of acquired tricuspid stenosis. The clinical diagnosis may be made by noting the giant "a" waves, the absence of pulmonary hypertension, the presence of the typical tricuspid diastolic murmurs, and the electrocardiographic evidence of an increased and pointed P wave in lead II. Some of these points may be absent or equivocal in patients with tricuspid stenosis. In that case the pathognomic sign is the altered pressure gradient found on cardiac catheterization of the right side of the heart. With tricuspid stenosis, moreover, the atrial diastolic pressure is raised above that of the ventricle, and in patients with sinus rhythm the atrial pulse pressure is abnormally high and the pulse pressure is not transmitted to the ventricle. A major problem in treatment is to decide which valve should be operated on first. If in doubt as to which valve was responsible for the greater degree of incapacity the authors prefer to operate on the mitral valve first so as to avoid excessive pulmonary congestion. If the main disability is due to the raised systemic venous pressure they prefer to operate on the tricuspid valve first. Patients are reassessed at short intervals after operation and the second valvotomy is proceeded with when maximum relief has resulted from the first operation.

Chesterman, J. T., and Whitaker, W. (1955). *Thorax*, **10**, 321.

Atrial septal defects

Operative repair under direct vision

LEWIS and his colleagues (1955) have repaired 35 atrial septal defects under direct vision. Under hypothermic anaesthesia they open the chest by a transverse sternal splitting incision, and explore the heart digitally through the right auricular appendage. Cardiac inflow and outflow are then occluded, and the right atrium opened widely. After repair the atrium is closed with a clamp over saline, circulation allowed to resume, and the atrial wound sutured. The duration of circulatory stasis was from 3 to 7¾ minutes. In all the cases in this series the atrial septal defect was the major anomaly, and the defects were classified into 4 types. Foramen ovale defects are caused either by arrested development of the septum secundum, or by inadequacy of the septum primum. The authors consider the latter to be the more important cause. In some cases the existence of a large valve of the inferior vena cava causes the defect to apparently extend to the right of the caval orifice, and is a serious complication that may lead to fatal misrepair. In some the right pulmonary veins open anomalously into the right atrium, and may require separate anastomosis. The defect is closed with fine silk sutures. Twenty-three cases came into this category. Five cases with high defects were seen; in these, the fossa ovalis was present, the defect being above it just below the superior vena cava. In each, there was anomalous entry of the upper right pulmonary veins. Careful placing of the sutures directed the pulmonary veins into the left atrium and closed the defect. One case had a combined high and foramen ovale defect. This was successfully closed. The fourth group consisted of low defects, stemming from failure of the common atrioventricular canal to close. Three of these had a low defect of the septum, notching of mitral valve cusps being the only other evidence of the developmental failure. Three had the more severe type, in which the atrioventricular valves were not properly developed, and not joined to each other, with a resultant communication between the ventricles. Those with only the atrial septal defect were closed by sutures, but received damage to the atrioventricular node. Those with the more serious type died after attempted repair, one showing signs of mitral stenosis before death. Eleven patients suffered ventricular fibrillation, 10 being successfully defibrillated. The authors conclude that open operative repair of atrial septal defects is a good method except in those cases with the last type of anomaly. Caution is necessary in the repair of low defects, both because of the anatomical difficulties, and because of the possibility of fibrosis producing valvular stenosis.

Lewis, F. J., Taufic, M., Varco, R. L., and Niazi, S. (1955). *Ann. Surg.*, **142**, 401.

Coarctation of the aorta

Criteria for surgical treatment

O'Sullivan, W D , and Glenn, F. (1955) *Ann. Surg* , **142**, 909.

Tetralogy of Fallot

Treatment

Anastomosis of ascending aorta and main pulmonary artery.—DAVIDSON (1955) describes a case of Fallot's tetralogy in a girl, aged 9, where an anastomosis was made between the

Anastomosis was performed in 1955 and the child made a good recovery. In another case of a boy aged 11 months where angiocardiography showed tetralogy of Fallot, the operation had to be abandoned and the baby died on the same day Necropsy showed an infundibular stenosis and gross narrowing of the segment containing the pulmonary valve Judging from the position of the suture line in the ascending aorta it seemed certain that the clamp used in operation had occluded the origin of the left coronary artery

Davidson, J. S. (1955). *Thorax*, **10**, 348

Intracardiac surgery

Pre-operative assessment and post-operative management

SELLERS (1955) states that the success of intracardiac surgery depends not only upon accurate surgical technique but also upon careful pre-operative assessment and post-operative management Preliminary measures include a full clinical and radiological study supplemented by cardiac catheterization and angiocardiography. It may be necessary to alter the plan of operation when the heart is directly inspected at thoracotomy At this stage the use of a sterile stethoscope applied to the heart surface ensures accurate location of abnormal sounds

available. Valvotomy for mitral stenosis is the most commonly performed operation in heart surgery The commissures of the mitral valve are split by forcible pressure with the side of the finger Sometimes a knife-like instrument is attached to the finger. The mortality from this operation is not greater than 5 per cent Transventricular valvotomy is performed in cases of pulmonary stenosis, and good results may be obtained from the use of hypothermia. Operations for aortic stenosis, aortic regurgitation and mitral regurgitation yield less satisfactory

results. With regard to interauricular septal defects a septum primum is less suitable for closure than a septum secundum. Operative treatment is indicated when there is progressive enlargement of the right side of the heart. Direct suture may be performed under open vision, with either hypothermia or an artificial heart-lung. External closure and invagination of the auricle wall are other techniques which may be employed.

Sellers, T. H. (1955). *Brit. med. J.*, 2, 1470.

VEINS—VARICOSE

See also B.S P., Vol. 8, p. 529, S. Key 344.

Management

Conservative and surgical treatment

COCKETT (1955) describes the management of venous ulcers of the leg. An elastic bandage is applied and the patient is encouraged to exercise the leg and calf. Continuous conservative treatment is reserved for patients in the upper age group and for patients who refuse operative treatment. With regard to diagnosis, the commonest precursor lesion is either a spray of fine dilated venules on the inner surface of the ankle or a firm plaque in the subcutaneous tissue. The plaque consists of oedematous and fibrotic fat with areas of fat necrosis and dilated veins. Ascending venography is employed in order to demonstrate the patency and configuration of the deep veins. Incompetent perforating veins at the ankle may also be demonstrated by means of this technique. When the patient is in the erect position the saphenous system has little place in the venous drainage of the ulcer-bearing area. The essential venous drainage is into the deep veins mainly through the large perforating veins on the inner and outer side of the leg. Hence in the early stages of ulceration large and incompetent perforating veins should be ligated at the ankle. The operation is performed after preliminary massage and the application of supporting bandages. Spirit and Cetavlon applications are used for the pre-operative preparation of the skin. With the operating table in a slight Trendelenburg tilt in order to minimize bleeding an incision is made from a point nearly half-way up the leg and one fingerbreadth posterior to the bony margin of the tibia. The incision is continued downwards to a point 1 inch postero-superior to the internal malleolus. Large veins in the subcutaneous tissue are explored until the perforating veins are located. Fine catgut is used for ligating any large perforating veins at the site of their emergence from the deep fascia, then the venous plexus in the subcutaneous tissue is removed. After excision of the ulcer the area is covered with tulle gras. A firm elastic-webbing bandage is applied from the toes to the knees and active movements are instituted as soon as possible. Cockett found incompetent perforating veins in approximately 66 per cent of 201 cases. A history of femoral thrombosis was obtained in 49 of 234 cases, and in this group it was necessary for the patients to continue the use of heavy elastic stockings despite the fact that the operation had proved to be successful in maintaining sound healing of the ulcer. In the majority of cases, however, surgical treatment enabled the patients to discard the stockings either throughout the day or for part of the day.

Cockett, F. B. (1955). *Brit. J. Surg.*, 43, 260.

NOTER-UP, 1956

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